DOES NOT CIRCULATE

Vol. 8 No. 1 JANUARY, 1954

UNIVERSITY OF MICHIGAN
APR 15 1954
MEDICAL LIBRARY

BRITISH JOURNAL OF PREVENTIVE & SOCIAL MEDICINE

EDITED BY

LANCELOT HOGBEN, THOMAS McKEOWN, and IAN TAYLOR

WITH THE ASSISTANCE OF

W. MELVILLE ARNOTT, *Internal Medicine*
DUGALD BAIRD, *Obstetrics and Gynaecology*
C. FRASER BROCKINGTON, *Public Health*
F. A. E. CREW, *Social Medicine*
G. P. CROWDEN, *Applied Physiology*
GUNNAR DAHLBERG, *Medical Statistics*
R. W. B. ELLIS, *Paediatrics and Child Health*
J. R. MARRACK, *Nutrition*
J. A. FRASER ROBERTS, *Human Genetics*
ALICE M. STEWART, *Social Medicine*
and the EDITOR of the *British Medical Journal*

CONTENTS

PAGE

The Changing Pattern of Mortality in England and Wales. I. Infant Mortality. WALLIS TAYLOR 1

Design of Records for Field Work. LANCELOT HOGBEN and K. W. CROSS .. 10

Incidence of Anencephalus, Spina Bifida, and Hydrocephalus Related to Birth Rank and Maternal Age. THEODORE H. INGALLS, THOMAS F. PUGH, and BRIAN MACMAHON 17

Incidence of Infectious Disease in the First Three Years of Life, Related to Social Circumstances. C. R. LOWE and THOMAS MCKEOWN 24

A Survey of Mental Hospitals and Mental Deficiency Institutions in the Birmingham Region. I. Mental Hospitals. K. W. CROSS 29

LONDON

BRITISH MEDICAL ASSOCIATION

TAVISTOCK SQUARE, W.C.1

YEARLY SUBSCRIPTION (4 NUMBERS) £2 2s. 0d. U.S.A. $7.00 SINGLE NUMBER 12s. 6d.

NOTICE TO CONTRIBUTORS

THE BRITISH JOURNAL OF PREVENTIVE AND SOCIAL MEDICINE is intended for the publication of original work in the field. Contributions in the English language from workers of any nationality may be considered for publication.

As understood by those who are responsible for this Journal, social medicine is that branch of science which is concerned with: (*a*) biological needs, interactions, disabilities, and potentialities of human beings living in social aggregates; (*b*) numerical, structural, and functional changes of human populations in their biological and medical aspects. To a large extent its methods must necessarily be statistical, involving the use of numerical data obtained either from official sources or from special field investigations, and interpreted in the light of established findings of the laboratory and of the clinic. Social medicine takes within its province the study of all environmental agencies, living and non-living, relevant to health and efficiency, also fertility and population genetics, norms and ranges of variation with respect to individual differences, and investigations directed to the assessment of a regimen of positive health.

All papers submitted for publication and all other editorial matters should be addressed to The Editors, BRITISH JOURNAL OF PREVENTIVE AND SOCIAL MEDICINE, c/o British Medical Association, Tavistock Square, London, W.C.1.

Papers are accepted on the understanding that they are subject to editorial revision, and that they are contributed to this Journal only. The Editors cannot undertake correspondence about papers returned as unsuitable on the advice of members of the Editorial Board.

Adequate reference should be made to previous work on the subject of the paper. A summary of observations and conclusions must be given.

Papers sent for publication must be typewritten on one side of the paper only, with double spacing and with a margin of at least 1½ inches. Illustrations should be used sparingly. Photographs should be printed on glossy paper and should be a little larger than the size desired for reproduction. Drawings and diagrams should be done in black ink on tracing linen, Bristol board, or stout, white paper. Any lettering on these drawings should be lightly inserted in pencil. The setting up of type by the printers will be much facilitated if attention is paid to the proportions of the standard page measurements. The Editors express the hope that contributors will study the conventions of shading and design of charts employed in the Journal with a view to standardizing visual symbols for ready recognition.

References should be arranged alphabetically at the end of the paper according to the Harvard system. If the reference is to a book, the place of publication, the number of the edition, and the page number should be given. In the text the year of publication must follow the author's name, more than one paper in any one year being indicated by a small letter (a, b, c) after the date. The reference should be given as follows: author's name, initials, year of publication (in parentheses), title of periodical (in italics, abbreviated according to the *World List of Scientific Periodicals*), volume number (bold type arabic numerals), and first page number (ordinary type arabic numerals); book titles (in roman and inverted commas), followed by publisher, place of publication, etc.:

Engle, E. T., and Shelesnyak, M. C. (1934). *Hum. Biol.*, **6**, 431.
Fluhmann, C. F. (1936). *Amer. J. Obstet. Gynec.*, **31**, 573.
—— (1939). " Menstrual Disorders." W. B. Saunders, Philadelphia.
Gómez, F. D. (1942). *Hoja tisiol.*, **2**, 25.

Contributors will receive one proof, but it is assumed that all but verbal corrections will have been made in the original manuscript; an allowance at the rate of ten shillings per sheet of sixteen pages is made for alterations in the proof (printer's errors excepted), and contributors will be responsible for any excess.

Twenty-five reprints of papers will, if desired, be provided free. A limited number of additional reprints at cost price can be supplied if application is made when returning proofs. An estimate of the cost will be given on application to the Publishing Manager, British Medical Association.

The Journal will be published quarterly.

Papers which have appeared in THE BRITISH JOURNAL OF PREVENTIVE AND SOCIAL MEDICINE remain the property of the Journal, and permission to republish them must be obtained from the Editors.

Applications for advertisement space should be addressed to the Advertisement Manager, British Medical Association, Tavistock Square, London, W.C.1.

NOTICE TO SUBSCRIBERS

Subscriptions (£2 2s. 0d. per annum) are payable to the British Medical Association.

Brit. J. prev. soc. Med. (1954), **8**, 1–9

THE CHANGING PATTERN OF MORTALITY IN ENGLAND AND WALES

I. INFANT MORTALITY

BY

WALLIS TAYLOR*

Department of Medical Statistics, University of Birmingham

1. Introduction

Planning the requirements of a Health Service pre-supposes the possibility of intelligent anticipation in a situation now changing in two ways:

(*a*) the risks of incurring any one disease in one and the same age group are not constant from year to year and in any one year may differ widely in different age groups;

(*b*) the age structure of the population of most industrialized communities—in Britain especially—is rapidly changing at the present time.

Such anticipation itself implies extrapolation; and no judgments which involve extrapolation can be final. They will be intelligent only in so far as they state foreseeable consequences within limits circumscribed by certain assumptions about the continued predominant influence of agencies operative at the present time and in the immediate past. While recognizing the dangers and limitations of such extrapolation, we need not lose sight of the fact that the future is in large measure predetermined by the past. Thus we can assign with no reservation an upper limit to the number of persons over 40 years of age in 1990 because all of them will be persons whose birth has been recorded already. With the reservation that mortality experience will not deteriorate as the result of a world war, mass unemployment, or other circumstance, we can also assign a lower limit. Such reservations will be less or more weighty in the measure that we do or do not extrapolate too far ahead of what current experience seemingly endorses.

To clarify the prospect as a basis for planning in the decade ahead, it is necessary to interpret current morbidity rates and their trends against the background of what we can now confidently forecast about the future age composition of the population. For the second, official sources are available. For the former it will be necessary to make an *ad hoc* study by recourse to data not as yet on record for a closed and representative population at risk. Such an inquiry, now planned in the Birmingham University Department of Medical Statistics with the assistance of the Rockefeller Foundation, is costly and beset with difficulties. Meanwhile, the series of preliminary communications, of which this is the first, aims at making available a preview of mortality changes *pari passu* with the changing age structure of the community.

It is a commonplace that most deaths occur in the first year of life or after the fifth decade; and our concern in this context is with infant mortality alone. Here our experience of change goes back less than half a century. The 20th century is the century of the conservation of child life, having witnessed a sustained quinquennial decline from a level lower than any previously recorded only since its first quinquennium. The study of this change has led different writers to widely different opinions. Thus Karl Pearson (1902) maintained that poverty had little to do with differential infant death rates and that the preservation of weaklings by welfare legislation would sooner or later exact its toll by producing more parents of low stamina. Contrariwise, Woolf and Waterhouse (1945) regard bad housing, employment of women, and other changeable features of the social environment as largely responsible for the differentials recorded up till 1940.

Of Pearson's views it sufficies to say that the present tempo of decline is greater than ever before. As regards the views expressed by Woolf and Waterhouse, it is worthy of comment that several recent investigations have cast doubt on the importance of social agencies contributory to differential *morbidity* of infants in the post-war situation (Grundy, 1949; Dykes, Grundy, and Lewis-Faning, 1953, Lowe and McKeown, 1954). Such findings may signify that there has been a relevant change, that social agencies affect morbidity less than mortality, that the methods of population sampling employed have not been sufficiently sensitive to the supposedly relevant social agencies, or that a clear view of the situation demands both a refined classification of diseases responsible for death and a

* University Research Fellow supported by the Rockefeller Foundation.

judicious selection of population units with sharply definable and divergent social indices.

If Pearson's prognostications have hitherto proved to be false, it is of interest to record that current figures have reached the target value deemed by Woolf and Waterhouse to be realizable as the outcome of drastic social reforms. Clearly, we can hope to make no intelligent prognostication of foreseeable changes in the next decade unless we scrutinize the trend of deaths attributable to different diseases; and it will facilitate the task of doing so if we clarify at the outset certain terms we shall use.

First it is necessary to define a *sustained decline*. By this we mean a decline which has continued from a certain date D to the present time on the understanding that:

(*a*) it reached on date D a level as low as in any previous year;
(*b*) we neglect annual fluctuations if the mean figure for a given quinquennium from D onwards is no greater than its predecessor.

Accordingly, we use *moving averages* (Fig. 1) in plotting the accompanying charts. Needless to say, a sufficient reason for neglecting annual variations is the confused picture which emerges from comparison of successive individual years in which even one large-scale epidemic may distort our interpretation of the course of events.

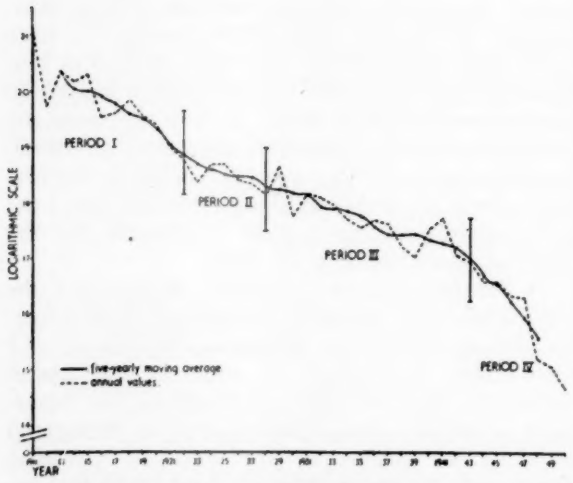

FIG. 1.—Infant mortality rates per 1,000 related live-born, 1911–50 (logarithmic scales).

It is necessary to emphasize our criterion of a sustained decline because it is relevant to what we shall speak of as the *hard-core* of the diagnostic breakdown. This hard-core includes deaths associated with congenital malformations and other categories of which we *cannot* predicate a sustained decline in the sense defined above. The rate for congenital malformations declined from a peak of 6·32 in the quinquennium 1936–40 to 6·04 for 1941–45 and 4·75 for 1946–50, but it is still well above 3·81, the figure for 1911–15. Thus no experience of the period 1911–15 justifies us in discounting the possibility that it may rise again, least of all that it will continue to fall below its present level.

It is also necessary to define precisely what we mean by the *tempo* of change, because we shall not deem a short-term forecast to be unduly optimistic if we make it on the understanding that:

(*a*) the tempo will increase no further;
(*b*) experience to date has shown that the tempo has been lately increasing.

To define it we need to remind ourselves that a 10 per cent. drop from a 30 per cent. level is *proportionately* three times as great as a 10 per cent. drop from a 90 per cent. level, and that a drop of 4 per cent. from a 30 per cent. level is indeed proportionately equivalent to a drop of 12 per cent. from a 90 per cent. level. A 1 per cent. drop from 2 to 1 per cent. is equivalent to a 50 per cent. reduction whereas a 1 per cent. drop from 50 to 49 per cent. is equivalent to only a 2 per cent. reduction. Thus an ordinary graph of rates against time will disclose a linear decline for the sequence 90, 80, 70, 60, 50 . . . whereas the proportionate decline will follow the course: . . . 11·1, 12·5, 14·3, 16·7 . . . The optical illusion disclosed by an ordinary graph of rates against time disappears when we plot the sequence on semi-log paper (Fig. 2, opposite). A fixed proportionate decline then follows the course of a straight line and an increasing proportionate decline the course of a line concave downwards. Since we speak of the tempo of decline as increasing or diminishing when the proportionate decrease is increasing or diminishing, the writer has plotted rates referable to each cause of death on a semi-log grid to get a general picture of the period; but all the data relevant to subsequent remarks about the changing tempo are to hand in Table IV.

These refinements of discourse are still necessary, because we too often read of "striking trends" when it is not quite clear what the word "trend" means in the context. If we look at the period from 1911–51, during which we can say with certainty that there has been a sustained decline of the infant death rate, we may distinguish four phases (Fig. 1):

(*i*) a decennium of quick tempo, *circa* 1913–22;
(*ii*) a quinquennium of steady tempo, *circa* 1923–28;
(*iii*) three quinquennia of increasing tempo, 1929–43;
(*iv*) a quinquennium of quick tempo, 1944–49.

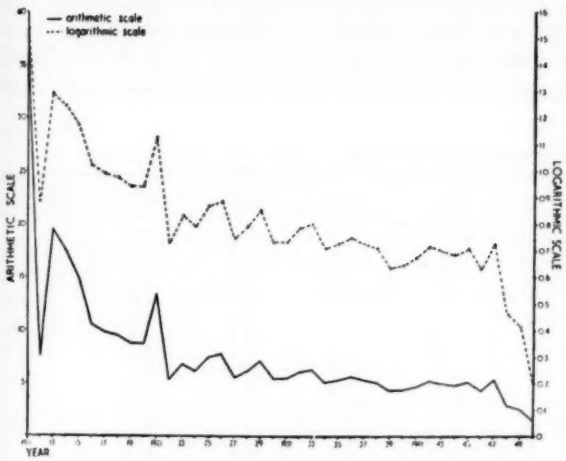

FIG. 2.—Logarithmic and arithmetic scales compared for diarrhoea and enteritis, 1911–50 (annual rates).

A superficial view of the increasing tempo during the period which covers the great depression and the beginning of a world war might lead us to be elated or depressed to the extent that we embrace a superficial eugenic or a superficial environmental view of the situation. The fact is that all short-term interpretations of time sequences of this sort are liable to error for several reasons, more especially the following:

(*i*) The date at which a measure of social reform receives its legal sanction may be many years before its full factual implementation, the implementation being gradual, not necessarily at an even tempo. We have but to think of the Multilateral School or Group Practice provisions of recent Acts. These likewise recall the law's delays and the lethargy of office after the Education Act of 1902, and the Act which replaced the Local Government Board by the Ministry of Health nearly 20 years later.

(*ii*) Similar remarks apply to the introduction of curative treatments, and in some measure to preventive procedures, if brought in by permissive legislation. The discovery itself may date from the year in which a few in the forefront of medicine first used a new treatment; but the education of the profession to use it sagaciously is a long story and the tempo of competent use is difficult to assess.

(*iii*) In any period, several putatively contributory agencies may be operative. To disentangle their several, not necessarily complementary effects, would be extremely difficult, if, as is often the case, we have no more to guide us than the date of an Act of Parliament or of a publication in a learned journal.

(*iv*) Agencies which may appear to have great importance in the light of later knowledge may be unsuspected till many years after they have ceased to be operative.

What we can discuss informatively with confidence is what individual diseases contributed more or less to the toll of infant mortality in the four periods we have here found it descriptively convenient to distinguish. The basic data are given in Table I, and Tables II–IV (overleaf) are based thereon to clarify their interpretation. If we loosely use the term *disease* for an entry on the death certificate, in contradistinction to a differential diagnosis, we may say that sixteen diseases appear ostensibly as causes of 91 per cent. of all infant deaths at the beginning and 87 per cent. at the end of the 40-year period.

The most spectacular event of the first period is the decline of summer diarrhoea. This is not a particularly novel disclosure, but it has an interest *vis-à-vis* (*iv*) above. It occurred in the decade of the swat-the-fly campaign and of the cheapening of motor transport which led to a reduction in the horse manure which encouraged the breeding of flies. How much the decrease in the fly population had to do with the decline of summer diarrhoea, no one can safely say. What we can say is that this guess is

TABLE I

QUINQUENNIAL AVERAGE RATES OF INFANT MORTALITY

	Cause of Death	1911–15	1916–	1921–	1926–	1931–	1936–	1941–	1946–50
1	Diarrhoea and Enteritis ..	19·[illegible]	9·46	7·83	6·42	5·62	4·94	4·96	3·35
2	Pneumonia	10·86	10·81	10·63	10·44	9·40	8·62	8·21	5·78
3	Tuberculosis	3·06	2·03	1·36	1·06	0·81	0·59	0·52	0·29
4	Non-meningococcal Meningitis	1·26	0·88	0·65	0·45	0·38	0·34	0·28	0·22
5	Whooping Cough	4·06	3·06	2·89	2·54	1·62	1·10	1·06	0·56
6	Diphtheria	0·24	0·23	0·19	0·19	0·10	0·10	0·07	0·01
7	Congenital Syphilis	1·41	1·76	1·05	0·70	0·38	0·19	0·18	0·09
8	Influenza	0·31	1·46	0·76	0·68	0·59	0·41	0·34	0·19
9	Measles	2·93	1·79	1·29	1·22	0·84	0·50	0·33	0·15
10	Bronchitis	8·26	8·04	5·25	3·74	3·35	2·31	1·93	0·86
11	Premature Birth	19·57	19·59	18·09	17·87	17·14	15·27	12·88	8·52
12	Congenital Malformation ..	3·81	4·03	4·16	4·92	6·02	6·32	6·04	4·75
13	Congenital Debility	12·56	9·78	6·07	4·11	2·89	2·05	1·42	0·55
14	Atelectasis and Asphyxia ..	1·69	1·58	1·53	1·56	1·87	2·15	2·15	3·05
15	Convulsions	8·75	6·88	4·27	2·76	1·93	1·29	0·86	0·26
16	Birth Injury	1·12	1·14	1·37	1·88	2·34	2·68	2·51	2·65
17	Remainder	9·94	8·73	7·05	6·93	6·51	6·49	6·54	4·82
	Total	108·88	91·25	74·44	67·47	61·79	55·35	50·28	36·10

as good as any, and if true was obvious at the time neither to vital statisticians with eugenic prejudices nor to those with a sympathetic ear to the local medical officer of health.

In the same period, we note an appreciable decline but at a slower tempo of infections including tuberculosis but excluding pneumonia. Pneumonia shows a slight decline from 1916–30 but declines at a quicker

TABLE II

PERCENTAGE CAUSE OF INFANT MORTALITY

	Cause of Death	1911–15	1916–	1921–	1926–	1931–	1936–	1941–	1946–50
1	Diarrhoea and Enteritis	17·5	10·4	10·5	9·5	9·1	8·9	9·9	9·3
2	Pneumonia	10·0	11·8	14·3	15·5	15·2	15·6	16·3	16·0
3	Tuberculosis	2·8	2·2	1·8	1·6	1·3	1·1	1·0	0·8
5	Non-meningococcal Meningitis	1·2	1·0	0·9	0·7	0·6	0·6	0·6	0·6
5	Whooping Cough	3·7	3·4	3·9	3·8	2·6	2·0	2·1	1·6
6	Diphtheria	0·2	0·3	0·3	0·3	0·2	0·2	0·1	—
7	Congenital Syphilis	1·3	1·9	1·4	1·0	0·6	0·3	0·4	0·2
8	Influenza	0·3	1·6	1·0	1·0	1·0	0·7	0·7	0·5
9	Measles	2·7	2·0	1·7	1·8	1·4	0·9	0·7	0·4
10	Bronchitis	7·6	8·8	7·1	5·5	5·4	4·2	3·8	2·4
11	Premature Birth	18·0	21·5	24·3	26·5	27·7	27·6	25·6	23·6
12	Congenital Malformation	3·5	4·4	5·6	7·3	9·7	11·4	12·0	13·2
13	Congenital Debility	11·5	10·7	8·2	6·1	4·7	3·7	2·8	1·5
14	Atelectasis and Asphyxia	1·6	1·7	2·1	2·3	3·0	3·9	4·3	8·4
15	Convulsions	8·0	7·5	5·7	4·1	3·1	2·3	1·7	0·7
16	Birth Injury	1·0	1·2	1·8	2·8	3·8	4·8	5·0	7·3
17	Remainder	9·1	9·6	9·5	10·3	10·5	11·7	13·0	13·4
	Total	100	100	100	100	100	100	100	100

TABLE III

PROPORTIONATE MEAN QUINQUENNIAL INFANT MORTALITY RATES

	Cause of Death	1911–15	1916–	1921–	1926–	1931–	1936–	1941–	1946–
1	Diarrhoea and Enteritis	100	49·7	41·1	33·7	29·5	25·9	26·0	17·6
2	Pneumonia	100	99·5	97·9	96·1	86·6	79·4	75·6	53·2
3	Tuberculosis	100	66·3	44·4	34·6	26·5	19·3	17·0	9·5
4	Non-meningoccocal Meningitis	100	69·8	51·6	35·7	30·2	27·0	22·2	17·5
5	Whooping Cough	100	75·4	71·2	62·6	39·9	27·1	26·1	13·8
6	Diphtheria	100	95·8	79·2	79·2	41·7	41·7	29·2	4·2
7	Congenital Syphilis	100	124·8	74·5	49·6	27·0	13·5	12·8	6·4
8	Influenza	100	471·0	245·2	219·4	190·3	132·3	109·7	61·3
9	Measles	100	61·1	44·0	41·6	28·7	17·1	11·3	5·1
10	Bronchitis	100	97·3	63·6	45·3	40·6	28·0	23·4	10·4
11	Premature Birth	100	100·1	92·4	91·3	87·6	78·0	65·8	43·5
12	Congenital Malformation	100	105·8	109·2	129·1	158·0	165·9	158·5	124·7
13	Congenital Debility	100	77·9	48·3	32·7	23·0	16·3	11·3	4·4
14	Atelectasis and Asphyxia	100	93·5	90·5	92·3	110·7	127·2	127·2	180·5
15	Convulsions	100	78·6	48·8	31·5	22·1	14·7	9·8	3·0
16	Birth Injury	100	101·8	122·3	167·9	208·9	239·3	224·1	236·6
17	Remainder	100	87·8	70·9	69·7	65·5	65·3	65·8	48·5
	Total	100	83·8	68·4	62·0	56·8	50·8	46·2	33·2

TABLE IV

TEMPO OF CHANGE

Each figure cited for a given quinquennium is the quinquennial rate expressed as a percentage of that of the previous quinquennium to exhibit the *tempo* of decline

	Cause of Death	1916–20	1921–25	1926–30	1931–35	1936–40	1941–45	1946–50
1	Diarrhoea and Enteritis	49·7	82·8	82·0	87·5	87·9	100·4	67·5
2	Pneumonia	99·5	98·3	98·2	90·0	91·7	95·2	70·4
3	Tuberculosis	66·3	67·0	77·9	76·4	72·8	88·1	55·8
4	Non-meningococcal Meningitis	69·8	73·9	69·2	84·4	89·5	82·4	78·6
5	Whooping Cough	75·4	94·4	87·9	63·8	67·9	96·4	52·8
6	Diphtheria	95·8	82·6	100·0	52·6	100·0	70·0	14·3
7	Congenital Syphilis	124·8	59·7	66·7	54·3	50·0	94·7	50·0
8	Influenza	471·0	52·1	89·5	86·8	69·5	82·9	55·9
9	Measles	61·1	72·1	94·6	68·9	59·5	66·0	45·5
10	Bronchitis	97·3	65·3	71·2	89·6	69·0	83·5	44·6
11	Premature Birth	100·1	92·3	98·8	95·9	89·1	84·3	66·1
12	Congenital Malformation	105·8	103·2	118·3	122·4	105·0	95·6	78·6
13	Congenital Debility	77·9	62·1	67·7	70·3	70·9	69·3	38·7
14	Atelectasis and Asphyxia	93·5	96·8	102·0	119·9	115·0	100·0	141·9
15	Convulsions	78·6	62·1	64·6	69·9	66·8	66·7	30·2
16	Birth Injury	101·8	120·2	137·2	124·5	114·5	93·7	105·6
17	Remainder	87·8	80·8	98·3	93·9	99·7	100·8	73·7
	Total	83·8	81·6	90·6	91·6	89·6	90·8	71·8

tempo after 1931. That the sulphonamides played some part in this is not unlikely; but the decline had noticeably gained momentum in the quinquennium (1931–35) before the introduction of sulphapyridine.

An outstanding feature of the last decade—our fourth period—is the tempo of decline of deaths attributed to premature births and the evanescent contribution of the infections—including tuberculosis. The *hard-core* of death categories of which we can record no sustained decline subsumes three major items:

(*i*) birth injuries;
(*ii*) asphyxia and atelectasis;
(*iii*) congenital malformations.

It is noteworthy both that the decade of mass unemployment signalizes no rise of any rate already declining, and that the present phase of higher tempo starts before the end of the second world war, when there was a great housing shortage. Neither the one nor the other indicates that remediable social evils play a minor or trivial role in determining the incidence of infant deaths; but if not, one conclusion is inescapable.

The cumulative effects of other agencies which had been gaining momentum in the antecedent period exercised an overriding effect in sustaining a decline which, but for these evils, would otherwise have proceeded at a much higher tempo. In short, we see in the health statistics of the 20th century an *inertia* which we may regard as the result of many *conceivably* contributory agencies not necessarily operating towards the same end: immunization, new therapies and free clinics, higher standards of medical and general education, improved sanitation, cleaner and dung-free roads, fewer flies, slum clearance and housing shortages, free meals and unemployment, sterile milk bottles, hire-purchase vacuum cleaners, new standards of personal cleanliness with a concomitant reduction of fleas and lice. Thus, the very complexity, which defies legitimate confidence in evaluation of the causal nexus in a time sequence, *operates to counteract any abrupt reversal of an established trend.*

For this reason, in short because the immediate future has been already conceived in the womb of the immediate past, we can take stock of the present situation in the light of past experience to forecast with some assurance an upper and a lower limit to the probable infant death rate at the end of the decade.

The outstanding features of the present situation are as follows:

Causes of Death	Average Rate (per thousand) 1946–50	As Percentage of 1941–45 Rate
Premature Birth ..	8·52	66·1
Pneumonia ..	5·78	70·4
Other Infections ..	5·72	59·2
Hard-Core ..	10·45	(97·7)
Remainder ..	5·63	63·8
Total	36·10	—

The figure in brackets against "Hard-Core" is not meaningful. The diseases included have not displayed any evidence of a decline, but have fluctuated throughout the period. The recorded figure (10·45) for 1946–50 is actually higher than for the quinquennium 1911–15 (6·62). Clearly an overall reduction of 50 per cent. referable to other categories in the decade 1951–60 is not unduly optimistic. This would bring the annual rate down to about 23·3, a figure which is still above that recorded in 1950 for Northampton, *viz.* 18. The writer hopes in a later communication to sharpen the outlines of the background picture for such a prognosis by analysis of local variations from sources other than the annual review of the Registrar General. Meanwhile, however, it will help us to an intelligent anticipation of the immediate future if we consider the main lethal diseases in greater detail, to bring the inertia of change into sharper focus. For sources and materials the reader may refer to the Appendix.

2. The Inertia of Change

Of the sixteen so-called causes of death only three retrogress frequently in the period 1911–51. These are the three categories (12, 14, and 16 in Tables I–III) already designated the "hard-core". If we regard as *no change* a trivial rise of the death rate for diarrhoea and enteritis during the second war (from 4·94 for 1936–40 to 4·96 for 1941–45), there is only one exception to the rule that the hard-core accounts for every increase of a specific quinquennial rate to a higher level than that of its predecessor. The exception (influenza (8) in the quinquennium of the great epidemic after the first world war) scarcely calls for comment. This appears from the following figures for crude increases and decreases:

Quinquennium		1916 to 1920	1921 to 1925	1926 to 1930	1931 to 1935	1936 to 1940	1941 to 1945	1946 to 1950
Change* in 16 Causes	None ..	2	—	1	—	1	2	—
	Fall ..	10	14	12	13	12	14	14
	Rise ..	4	2	3	3	3	—	2
No. of Rising Causes .. (*see* Table III)		8, 12 14 16	12 16	12 14 16	12 14 16	12 14 16		14 16

* One per cent has been the critical level for assessing a change.

Seen in these terms, the period 1911–51 is a record of consistent progress, except in so far as the hard-core fluctuates without any indication of progression. This uniformity takes no stock of the *tempo* of change. A different picture emerges, Table IV, if we classify the period in terms of disease rates which show a higher, lower or zero proportionate change, as below:

Quinquennium		1916 to 1920	1921 to 1925	1926 to 1930	1931 to 1935	1936 to 1940	1941 to 1945	1946 to 1950
Disease Rates	Rise ..	4	7	12	7	4	8	2
	Fall ..	10	9	2	9	10	7	14
	No Change	2	1	2	—	2	1	—

This exhibits clearly the force of previous remarks with reference to the period of unemployment and to the second world war. It sufficiently justifies a rough and ready four-fold division of the period as above. As elsewhere stated, the worst quinquennium is 1926–30—immediately *before* the great depression, and it would be idle to attempt an explanation of this.* It merely illustrates the difficulties of interpreting a time sequence when an agency dated on paper at *D* may not become fully operative in practice till $D + x$, the x being unknown. From our present viewpoint, what it brings into focus most clearly is that the last two quinquennia have witnessed a steepening decline embracing nearly all categories other than the hard-core. From our experience of the inertia of change during the past 50 years, we may anticipate with little misgiving that external events other than an atomic war will accomplish no more than a retardation of the present tempo of decline in the forthcoming decade.

3. Disease Patterns

The unwisdom of seeking to isolate any social agencies responsible for a declining total death rate comes into focus when we compare more closely the courses pursued by each of the thirteen lethal diseases which have consistently and concurrently declined in the period covered by Tables I–III. As Table II shows, the proportionate contribution of all epidemic or communicable diseases has declined from 47·3 per cent. in 1911–15 to 31·8 per cent. in 1946–50. For the same periods diarrhoea and enteritis contributed 17·5 per cent. in 1911–15 and 9·3 per cent. in 1946–50, pneumonia 10 per cent. in 1911–15 and 16·0 per cent. in 1946–50. In the absence of any indications that the hard-core will yield, the *pace-makers* of decline in the forthcoming decade will be pneumonia, diarrhoea and enteritis, and premature birth, their proportionate contributions in 1946–50 being respectively 16, 9·3, and 23·6 per cent. (in all 48·9 per cent.). The proportionate contribution of the hard-core was then 28·9 per cent.

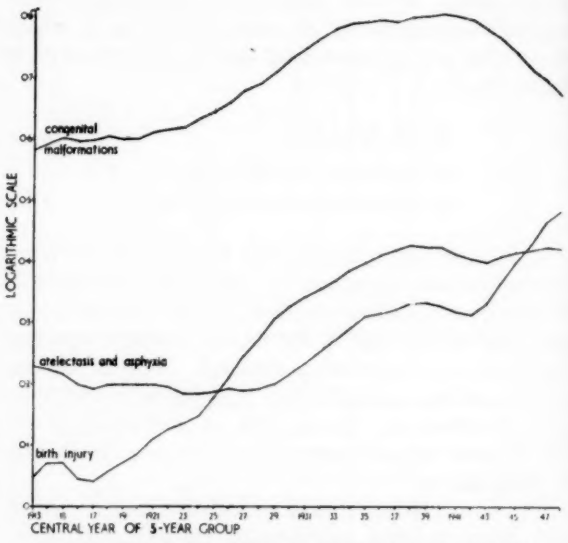

FIG. 3.—Infantile death rates for the "hard-core", 1911–50.

Of the communicable and epidemic diseases, some (notably *diphtheria* and *measles*) have virtually disappeared as ostensible causes of infant deaths. In disappearing they have lost the statistical *facies* of the epidemic category The annual figures no longer record such violent fluctuations for whooping cough or for diarrhoea and enteritis. This is not true of influenza, but the highest quinquennial rate recorded for influenza is 1·46 per thousand (1916–20), and the highest annual rate over the same period (1911–50) is 3·73 for 1918. This means that a large-scale influenza epidemic might appreciably compromise a reasonable single year forecast, say for 1960; but not greatly the quinquennium of which it is the mid-year. Otherwise, the lethal diseases which call for special comment are:

(1) *Diarrhoea and Enteritis.*—Table IV discloses four phases of a sustained decline: quick tempo 1911–20, steady slow tempo 1921–40, no change 1941–45, quick tempo 1946–51.

(2) *Pneumonia* declined at a steady slow tempo from 1911–45. The quinquennium 1946–50 records a quick tempo of decline.

(3) *Premature Births* declined at a steady slow tempo from 1921–45. The quinquennium 1946–50 records a quick tempo of decline.

* The general strike, of course, occurred in 1926, and before and after this date there was large-scale unemployment in the coal mining districts. It may well have been that these areas of notoriously high mortality were partly responsible for the substantial increases recorded for England and Wales.

The foregoing remarks show that the last quinquennium signalizes a new rapid tempo of decline for each of the three so-called causes of death specified above as the pace-makers of the current situation. The same remarks apply specifically to diphtheria, non-meningococcal meningitis, tuberculosis, diphtheria, whooping cough, influenza, congenital syphilis, measles, and bronchitis, diseases whose individual contribution is trivial, though collectively appreciable. With three exceptions all the communicable and epidemic diseases have consistently declined as so-called causes of death throughout the whole period 1911–50. The exceptions, other than diarrhoea and enteritis (1941–45), are influenza and congenital syphilis, which declined from 1921–25.

However, the tempo of decline is very variable. Diphtheria declined as a cause of infant deaths very slowly till the quinquennium 1941–45, then with gathering momentum. Congenital syphilis declined rapidly after 1920 except during the second world war (1941–45), which almost completely arrested the decline. For meningitis (non-meningococcal) and whooping cough, the quinquennium 1916–20 registers rapid decline, the next quinquennium a slow one. The reverse is true of influenza and bronchitis. The tempo of decline for measles remained fairly rapid throughout the period, except in the quinquennium 1926–30; nonetheless, the increased tempo of decline in the quinquennium 1946–50 is outstanding. Further comment is unnecessary. The Tables show that agencies contributory to the composite picture of a sustained decline clearly discriminate between different diseases, whence no attempt to identify the causal nexus is likely to succeed without due regard to the specific disease components.

TABLE V

TOTAL INFANT MORTALITY, NEONATAL MORTALITY, AND STILLBIRTH RATE

Year	Total Infant Mortality		Neonatal Mortality		Stillbirth Rate	
1911	129·4	1,000	40·6	1,000	—	—
1912	94·6	731	38·4	946	—	—
1913	108·8	841	39·5	973	—	—
1914	104·5	808	38·5	948	—	—
1915	107·2	828	37·7	929	—	—
1916	90·2	697	36·9	909	—	—
1917	91·7	709	37·1	914	—	—
1918	96·9	749	36·6	901	—	—
1919	90·3	698	40·4	995	—	—
1920	87·2	674	35·0	862	—	—
1921	79·7	616	35·2	867	—	—
1922	75·1	580	33·9	835	—	—
1923	68·8	532	31·9	786	—	—
1924	74·2	573	33·0	813	—	—
1925	74·4	575	32·3	796	—	—
1926	69·7	539	31·8	783	—	—
1927	68·4	529	32·2	793	—	—
1928	65·3	1,000	31·1	1,000	40·1	1,000
1929	73·8	1,130	32·8	1,055	40·0	998
1930	60·1	920	30·9	994	40·8	1,017
1931	65·8	1,008	31·5	1,013	40·9	1,020
1932	64·5	988	31·5	1,013	41·3	1,030
1933	62·6	959	32·1	1,032	41·4	1,032
1934	59·1	905	31·4	1,010	40·5	1,010
1935	57·0	873	30·4	977	40·7	1,015
1936	58·7	899	30·2	971	39·7	990
1937	57·8	885	29·7	955	39·0	973
1938	52·9	810	28·3	910	38·3	955
1939	50·6	775	28·3	910	38·1	950
1940	56·7	868	29·6	952	37·2	928
1941	59·3	908	29·0	932	34·8	868
1942	51·2	784	27·2	875	33·2	828
1943	49·6	760	25·2	810	30·1	751
1944	45·7	700	24·4	785	27·6	688
1945	45·6	698	24·8	797	27·6	688
1946	43·1	660	24·5	788	27·2	678
1947	42·7	654	22·7	730	24·1	601
1948	33·2	508	19·7	633	23·2	579
1949	32·1	492	19·3	621	22·7	566

4. STILLBIRTHS AND NEONATAL MORTALITY

Our specification of the hard-core on the one hand and of premature birth on the other as one of the three pace-makers in the present situation calls for a brief comment on neonatal mortality and stillbirths. Table V cites all infant (under one year) and neonatal (first month) annual death rates for the 40-year period, together with annual stillbirth rates since they were first officially recorded as such. Both columns exhibit what we all know and what we might expect from the components of the hard core, *viz.* that both the stillbirth rate and the neonatal birth rate have declined less steeply than the total infant death rate. What is of more interest is whether the course of the stillbirth rate can throw any light on the vagaries of the hard-core, and hence on whether we need attach any importance to the fact that the recorded incidence of congenital malformations has declined steeply since the peak quinquennium of 1936–40. The quinquennial figures reveal no clear tie-up between stillbirths and deaths attributable to congenital malformations or to birth injuries; but stillbirths decline *pari passu* with a rise of deaths attributable to asphyxia and atelectasis. Till 1940 deaths due to congenital malformations rose while the total neonatal death rate was falling.

	Cause of Death	1911–15	1916–21	1921–25	1926–30	1931–35	1936–40	1941–45	1946–50
1	Stillbirth	—	—	—	40·3*	41·0	38·5	30·7	24·3
2	Neonatal mortality	38·9	37·2	33·3	31·8	31·4	29·2	26·1	21·5
3	Congenital Malformation	3·81	4·03	4·16	4·92	6·02	6·32	6·04	4·75
4	Birth Injury	1·12	1·14	1·37	1·88	2·34	2·68	2·51	2·65
5	Atelectasis and Asphyxia	1·69	1·58	1·53	1·56	1·87	2·15	2·15	3·05
6	Total Infant Mortality	108·88	91·25	74·44	67·47	61·79	55·35	50·28	36·10

* 1928–30

The annual rates disclose a positive correlation (*product-moment*) of 0·56 between deaths attributable to birth injuries and deaths attributable to asphyxia and atelectasis for the period 1931–49. These were rising in 1941–49 while the death rate with regard to congenital malformations was falling (Fig. 3). Did considerable positive or negative correlation exist between the latter and stillbirths, we might venture to answer the question stated above in one way or another. As matters stand, we can make no reasonable forecast to the effect that the contribution of the hard-core to the infant death rate in the forthcoming decade will be a little higher or a little lower at the end of it.

5. Immediate Prospect

We have seen that the inertia of change encourages us to anticipate no abrupt reversal of a composite trend. If we assume that the mean tempo of change with regard to deaths attributable to all sources other than the hard-core stabilizes at the 1946–50 level, the figure we should assign to 1960 would lie in the range 20·3 to 22·3 on the alternative assumptions that the rate referable to the hard core remains at the 1950 level or retrogresses to the 1940 level. If we assign the peak quinquennial figure for the period 1911–50 as the hard-core quota of 1960, we get as the total rate 21·8. As stated, in any single year a grave epidemic of influenza might substantially raise the level. On a very conservative view, we may alternatively suppose that the decline continues at the tempo of the 1946–50 quinquennium, through the ensuing quinquennium without any further decline in the next. This would assign to 1960 a rate of about 26·5.

As a more optimistic view the figures cited in Table VI were obtained by a least-squares fit of a negative exponential to each item separately, the origin being the date at which the present phase appears to have begun.

In a recent communication (Taylor, 1952), the writer put forward the view that perhaps Pearson's pessimistic prognostication that attempts to reduce infant mortality are self-defeating inasmuch as they favour the survival of genetically inferior stock might soon prove to be correct, although it was certainly untrue in Pearson's own day. The results of this investigation show clearly that we are not yet near such a residual level of infant mortality. Moreover, the so-called *expectation of life* is increasing annually for all age groups, at a time when infant mortality rates are declining. Presumably therefore, Pearson's "genetically impoverished" children must be contributing to this progress. The writer accordingly adheres more firmly to his original view (Taylor, 1951) that we are nowhere near a state when further conservation of infant life will produce only such as fail to run their normal span of life.

6. Summary

1. Throughout the period 1911–50, sixteen named categories of disease have been the ostensible cause of 87 per cent. or more of all infant deaths. With respect to all but three of these (*congenital malformations*, *birth injuries*, and *asphyxia* or *atelectasis*) herein called the *hard-core*, we may record a *sustained decline* in a sense precisely defined on p. 2.

2. For all categories except the *hard-core*, the last two quinquennia have witnessed an increasing tempo of decline in the sense precisely defined on p. 2.

Table VI

PRESENT AND PREDICTED INFANT MORTALITY RATES

	Cause of Death	1940	1945	1950	1955	1960	1965
1	Diarrhoea and Enteritis	4·75	4·87	1·83	0·49	0·13	0·04
2	Pneumonia	8·02	6·94	6·01	5·21	4·51	3·91
3	Tuberculosis	0·55	0·39	0·29	0·21	0·15	0·11
4	Non-meningococcal Meningitis	0·29	0·23	0·18	0·14	0·11	0·08
5	Whooping Cough	1·14	0·78	0·53	0·36	0·25	0·17
6	Diphtheria	0·10	0·03	—	—	—	—
7	Congenital Syphilis	0·17	0·15	0·04	0·02	0·01	—
8	Influenza	0·47	0·26	0·14	0·08	0·04	0·02
9	Measles	0·36	0·20	0·12	0·07	0·04	0·02
10	Bronchitis	1·95	1·28	0·84	0·55	0·36	0·24
11	Premature Birth	16·58	10·97	7·26	4·81	3·18	2·11
12	Congenital Malformation	6·62	5·52	4·39	4·39	4·39	4·39
13	Congenital Debility	1·91	0·95	0·47	0·23	0·12	0·06
14	Atelectasis and Asphyxia	2·43	2·43	2·43	2·43	2·43	2·43
15	Convulsions	1·23	0·56	0·08	0·01	—	—
16	Birth Injury	2·62	2·62	2·62	2·62	2·62	2·62
17	Remainder*	7·38	5·73	4·08	3·24	2·75	2·43
	Total	56·57	43·91	31·31	24·86	21·09	18·63

* The remainder has been taken as a constant 15 per cent. of all specific items, *i.e.* it is the least calculable and least reliable factor. The 1940 and 1945 values are not those recorded but those "expected" on the same basis as the extrapolation. It can be seen that in fact they differ little from the recorded values.

3. At the beginning of the 40-year period, the hard-core accounted for 6·1 per cent. of all infant deaths, at the end for 28·9 per cent. of all deaths. Thus we have still far to go before we can see the end of the continuous decline of the infant death rate during the 20th century.

4. In the absence of unforeseen agencies which will attack the hard-core, the pace-makers of decline in the forthcoming decade are *diarrhoea* and *enteritis*, *pneumonia*, and *premature birth*. These together accounted for 48·9 per cent. of all infant deaths in 1950.

5. Detailed study of the causes of death at different periods from 1900–50 lead us to conclude that a phase of decline has an inherent *inertia*, in virtue of which short-term extrapolation is legitimate with due reservations. With such reservations, we have seen good reason to anticipate in 1960 an infant death rate not appreciably higher than 20 per 1,000.

6. With due regard to the components of the total infant death rate, one need anticipate no grounds for pessimism of the sort expressed by Karl Pearson until it has fallen far below what is likely to be the level in 1960. Indeed a reasonable target value is not much above 10, even on the conservative assumption that research into congenital malformations, birth injuries, or asphyxia and atelectasis makes little useful progress.

My acknowledgments are due to Professor Lancelot Hogben, F.R.S., for his advice and criticism.

REFERENCES

Dykes, R. M. (1950). "Illness in Infancy." Leagrave Press, Luton.
——, Grundy, F., and Lewis-Faning, E. (1953). *British Journal of Preventative and Social Medicine*, **7**, 31.
Grundy, F. (1949). *Med. Offr*, **81**, 144.
Lowe, C. R., and McKeown, T. (1954). *British Journal of Preventive and Social Medicine*, **8**, 24.
Pearson, K. (1902). *Biometrika*, **1**, 263.
Taylor, W. (1951). *British Journal of Social Medicine*, **5**, 162.
—— (1952). *Ibid.*, **6**, 226.
Woolf, B. (1947). *Ibid.*, **1**, 73.
—— and Waterhouse, J. A. H. (1945). *J. Hyg., Lond.*, **44**, 67.

APPENDIX

Method and the International Classification

Since 1911 several major changes in the classification of cause of death in infant mortality returns (*vide infra*) have taken place. For this reason it is not possible merely to extract the mortality rates calculated annually by the Registrar General. For this communication, therefore, the number of deaths recorded for each specific cause have been extracted from the Annual Reviews, special regard being paid to changes of classification, and the rates have been calculated on a uniform basis throughout the period.

The greatest change in procedure came in 1940 when new rules for the classification of death resulting from several causes became operative. It has been possible and thought least misleading to locate this disjunction at the centre of the period, *i.e.* between 1930 and 1931. Thus with due reference to changing fashions in diagnosis, as discussed in the text, the values are strictly comparable from 1911 to 1930 and from 1931 to 1950. The break is quite unimportant for many causes of death. The exceptions to this are discussed in the text.

In 1950, when the sixth revision became operative, more changes were made. The effect of these may be summarized as in next column. The Registrar-General's Tables give new figures back for 10 years. From these it is clear that:

Cause of Death	Change	Percentage of Previous Level
Pneumonia	higher	105
Influenza	lower	76
Bronchitis	lower	95
Premature Birth	lower	89
Congenital Malformations ..	lower	93
Convulsions	lower	89
Non-meningoccocal Meningitis	slightly changed in definition, without great change in numbers recorded.	

Congenital Debility has been replaced by a new group (773) "Ill-defined diseases peculiar to early infancy". The reader can therefore make any requisite changes in the table of extrapolation based on the fifth classification.

In the twentieth century the International List of Causes of Death has been revised six times. Since the dates on which the revisions became operative are not the dates when the revisions were made and by which they are classified, which usually precede the operative dates by one or two years, it may help to classify the revisions as follows:

Revision	Date	When first used in England and Wales	Details Published
1st	1900	Never	—
2nd	1909	1911	Registrar-General's 74th Annual Report, 1911, p. *viii*.
3rd	1920	1921	Registrar-General's Stat. Review, Med., 1921, p. 482.
4th	1929	1931	Registrar-General's Stat. Review, Med., 1931, p. 401
5th	1938	1940	Registrar-General's Stat. Review, Med., 1940, p. 321.
6th	1948	1950	Bulletin of the World Health Organization, Supplement 4, "Comparability of Statistics of Causes of Death according to the Fifth and Sixth Revisions of the International List".

Brit. J. prev. soc. Med. (1954) **8**, 10–16

THE DESIGN OF RECORDS FOR FIELD WORK

BY

LANCELOT HOGBEN and K. W. CROSS

From the Department of Medical Statistics, University of Birmingham

There is little doubt that large numbers of physicians and medical officers could usefully collaborate in a great variety of large-scale inquiries of no mean importance, if research workers themselves were more fully aware of the need for designing records with due regard to certain principles which the medical curriculum does not as yet accommodate. Current supervision of case notes in medical instruction and current methods of completing them in almost all hospitals still adhere to a traditionally narrative pattern, entrusting the observer to use his or her own discretion about what to record or when to record it. Even when the topic of interest is the single individual, as in a type of inquiry recently discussed by Hogben and Sim (1953), the wastage of information by reliance on the narrative record may be enormous; but it is inevitably so if we seek to pool information about different individuals and from different sources. If the record then contains no reference to a particular attribute (A) of a particular individual, we have no certain clue to which of three possibilities is correct:

(*a*) the individual was *not-A;*
(*b*) the individual was A, but the observer did not deem the fact to be worth recording;
(*c*) the individual was *A*, but the observer forgot to mention it in the case summary.

One example from published work (Hogben, Worrall, and Zieve, 1932) on the genetic basis of alcaptonuria will make this clear. Available records of individuals with this condition disclosed the following results referable to 45 fraternities containing in all 125 sibs:

Relationship of Parents	Fraternities	Alcaptonurics
First cousins ..	12	26
First cousins, consanguineous of unknown degree	1	1
Unrelated	20	36
Unstated (if any) ..	12	20
Total	45	83

If we confine our attention to individuals concerning whose parentage we have definite information, the sample percentage of alcaptonurics with consanguineous parents is therefore 42. If we assume that parents are not consanguineous unless otherwise stated, the percentage is 24·4; and there are good enough theoretical reasons for being well-nigh certain that the lower figure is correct. Thus the alcaptonurics illustrate the truism that writers of case histories in essay form are prone to record information only if it seems to call for special comment. *Unless records explicitly call for information, what information they do supply is of little, if any, value.*

This is true of almost any medical investigation which takes within its scope records of different individuals and observations on different occasions; but it is still more true when observers with different standards of what is important collaborate, especially when the designation of one and the same sign or symptom involves an act of *interpretation.* Thus a preliminary desideratum of such investigation is a proforma which contains no terms other than those which are verbally definable by general admission and otherwise explicitly in the context, or are valid in the sense that they conform to the criterion of the *identity parade.* In truth, ambiguity may arise at a much more elementary level. Thus the item "(1) *married;* (2) *not married*", set out as an exclusive *A* or *not-A* attribute in a *niche* for the marital status of the individual, leaves the observer free to place a divorced person in either category, unless the words *as yet* or *hitherto* follow the negative particle.

What is less widely recognized is that each such *niche* of the observational record should also be statistically* unambiguous in the sense that the attributes it accommodates constitute an *exclusive* and *exhaustive* set in the sense that:

(*a*) no more than one attribute of the set specified can pertain to one and the same individual;
(*b*) every individual is specifiable by one such attribute.

Interpreted literally, the last requirement is a council of perfection, but we can satisfy the requirements of an exclusive-exhaustive taxonomy by the

*In speaking of a taxonomic specification as *statistically* unambiguous if exhaustive and exclusive as here defined, we do so because repeated enumeration till totals agree is highly wasteful. If the classification is exhaustive, the total recorded for any *niche* will be the size of sample, and if exclusive the sum of the enumerated subsets indicated by the code numbers for the several rows will be equivalent thereto. We then have a double check on the reliability of the enumeration without recourse to repetition.

device of the open cell: *other—unspecified—doubtful.* Bacon remarks that nature is more diverse in her operations than is man in his conceptions; and it is indeed prudent to employ the open-cell even if disposed to believe both that the nomenclature is unequivocal and that it covers all contingencies. Two items in an obstetrical record designed by the Department of Medical Statistics sufficiently illustrate its use (16 and 17 at foot of page).

Here Item 16 is *exhaustive* in the sense that it allows for a positive, negative or doubtful test and for no test at all. As it stands, it is not *exclusive* unless we also know (as we did) that:

(*a*) an individual if tested would have submitted to one only of the three tests specified;

(*b*) no other laboratory test was in use at the time.

Such then are the elementary desiderata of a record for research involving observations on different individuals or even (Hogben and Sim, 1953) on the same individual, more especially if different observers collaborate; and one may hazard the opinion that medical students would get a better training in the art of observation and in medical semantics, if required to complete a predesigned record appropriate to the type of case instead of relying on individual judgment set out in narrative. Be that as it may, the art of designing the best form such a record may take is one which comes by long experience only, in the absence of any texts which fully discuss the issues involved. Hence the hope that what follows will be of service to research workers in medicine.

The choice of words and categories referred to in the foregoing remarks is by no means always an easy intellectual exercise; nor is the need for it self-evident. What makes the need for a statement of principles more pressing is that clarity is not enough. It does not suffice to ensure that we shall record all the information we require and that we have no doubts about the meaning of what we have recorded. Other desiderata of the design of the record are the possibility of rendition and of extracting the data for analysis with minimal effort. If the investigation subsumes a very large number of records, the last-named requirement implies suitability for enlisting mechanical devices for sorting or tabulation. Even when the records are relatively few, it will be possible to delegate the task of extracting the data for tabulation to a clerical assistant with confidence only if it is also possible to formulate instructions for a hand-sort in terms which require no technical acquaintance with the topic.

A layout which permits the fullest use of mechanical aids is equally suitable for a hand-sort by a clerical assistant. Mechanical aids first came into use for enumeration, costing, and tabulating information which is largely numerical, as in accountancy. If the data of a record are qualitative, it will be possible to feed the information to the machine only if translated into its own language, *i.e.* a numerical code. The salesman's view, encouraged by experience of accountacy, the totalizator, and market research, is that the bottleneck of mechanical aids is the operation of punching and verifying. We have listened to many discussions on the value of photo-electric devices for eliminating the punch-card, and have no doubt that one or other will come into general use eventually; but the effort expended and the liability to error incurred in conveying coded information to a punch-card is trivial in comparison with the problem of translating highly-specialized information involving an immense vocabulary of technical terms into a code. If we are to make the fullest use of case history material, we must find

Col. No. 16. Pregnancy Diagnosis Test Performed	None	Aschheim-Zondek			Friedmann			Hogben		
		Positive	Negative	Doubtful	Positive	Negative	Doubtful	Positive	Negative	Doubtful
Code (*row*)	0	1	2	3	4	5	6	7	8	9

Col. No. 17. Ante-Natal Care	None	Hospital Out-Patient Department	Private Practitioner	Hospital Out-Patient Department and Private Practitioner	Corporation Ante-Natal Clinic	Corporation Ante-Natal Clinic and Private Practitioner	Corporation Ante-Natal Clinic and Hospital Out-Patient Department	Other (*specify*) .....
Code (*row*)	0	1	2	3	4	5	6	9

Specify ante-natal clinic.....

some means of *coding at source*. By coding at source, we mean that the expert observer must be his own translator.

In what follows we may assume that the machine operates with punched cards, and that the layout of the observational record suffices to give all the necessary instructions to the operator responsible for punching. Accordingly, it will show on the left-hand margin of each *niche* the column or columns which accommodate the corresponding items of information and on the right-hand a *box* to accommodate the specification of the appropriate row to punch. As stated, no problem of translation arises when the information is intrinsically numerical:

16–18 Systolic blood pressure (mm.) 8 a.m. | | | |

19–21 Systolic blood pressure (mm.) 10 p.m. | | | |

22–23 Erythrocyte count ($\times 10^{-5}$) | | |

Here it suffices to insert the relevant numbers in the box. For instance, a red blood count of 3,700,000 will appear as | 3 | 7 |, signifying that the punch-card operator punches Row 3 in Col. 22 and Row 7 in Col. 23. Similarly, a red blood count of 900,000 will appear as | 0 | 9 | .

We may here assume that we use ten rows per column, labelled 0–9, in the simplest way. Only one hole will then appear on any column of the punch-card. By use of additional X and Y rows, a column can in fact accommodate any one of more than ten units of information, and some machines interpret more than one hole per column; but the investigator who is not *au fait* with the subtleties of the machine's performance will be wise to follow a plan which—if less economical than it need be—is easy to understand and to interpret when the time comes to issue appropriate instructions for sorting and tabulating the information which the machine can digest.

Much information can be explicitly coded by recourse to an instruction to ring or tick the appropriate item as illustrated by (15) the second item of a record for cases of cerebral thrombosis:

13–14 Duration of Stay (*days*) 01 to 99 (= 99 or more) | | |

15 Initial Speech

Speech Normal		Speech Defective		Aphasia without Comprehension	
B.P. Normal	Hyper-tensive	B.P. Normal	Hyper-tensive	B.P. Normal	Hyper-tensive
0	1	2	3	4	5

In contradistinction to *self-coding*, as illustrated by the above, we must sometimes rely on *coding by reference*, in which event it is wise to give the appropriate verbal specification below, leaving completion of the document by recourse to the code till the observational record is otherwise complete. For instance, we may lay out *diagnosis* as below by recourse to the W.H.O. list of diseases:

Diagnosis (Code K). Specify..... | | | | |

There are unfortunately few such codes available for use, and of these some are too bulky or open to objection on other grounds. For England and Wales, the official *Industry Code* would be adequate as it stands if the employed person could produce any document disclosing his or her code specification. Actually, the employer retains the only document on which this specification appears. This dilemma calls for official intervention at a high level, pending which we cannot use it to code industry. Unlike the official code of industries, the Ministry of Labour numbered list of *occupations* is too vast for Record Office use and is ill-adapted to the requirements of occupational medicine without translation into a secondary code based on taxonomical categories relevant to the end in view. Accordingly, it may be preferable to use an *ad hoc* code specifying medically relevant conditions of work (*e.g.* sedentary, nocturnal, outdoor, migratory), responsibility, and training, in contradistinction to explicit denomination of the patient's job.

As an example of such a layout for a miniature code with appropriate instructions for the benefit of the user, we have recommended the following:

Occupation | | | | |

Code G Code H

Employment Status (Code G)

To operate Code G first ask whether the patient is an employee, and check answer if Yes by asking name of employer(s). Then place in 41–57 by appropriate questions. Be careful to distinguish *clerical work* (*routine* typing, shorthand, book-keeping) from *administrative work* (including *responsible* secretarial posts and qualified accountants). If the answer to the first question is No, the only difficulty which calls for comment is the distinction between the man or woman on his own (*self-employed*) and the employer. A shop-proprietor or farmer who has help from a relative or relatives *not* registered employee(s) for National Insurance is in this context *self-employed*.

No Occupation:

Independent means (other than savings or pension from previous employment)	01
Retired	02
Housewife or homeworker (not in receipt of wage or salary)	10
Schoolchild	11
Other dependent	12

Self-Employed:	
Profession (private practice)	11
Other	20
Employer (owner or partner)	30
Employee:	
Managerial or Administrative (executive grade)	41
Professional (other than above)	42
Foreman, Supervisor	43
Clerk	44
Salesman, Shop Assistant	45
Porter, Messenger	51
Domestic, *Resident*	52
Domestic, *Non-resident* (cleaners, canteen, counterhands, waiters)	53
Caretaker, Watchman	54
Car Park or Lift Attendant	55
Skilled or Semi-skilled Artisan	56
General Labourer	57
Other	89
Unspecified	99

Place of Work (Code H)

To operate Code H it is necessary to be clear about the distinction between B (*temporary*) and C (*mobile*). A person whose place of work is temporary (B) here signifies one who habitually changes his place of work (*plumber, interior-decorator, jobbing gardener, gas-fitter, piano-tuner*. A person whose work is mobile is one who is continually on the move (*postman, milkman, messenger, engine-driver, bargee, bus-conductor*. Code *commercial travellers* as Temporary (mixed) 40. If in doubt, code as 99.

A. *Fixed*	
Private Dwelling	11
Factory or Workshop (other than 22)	21
Repair Shop	22
Retail Shop or Showroom	23
Warehouse	24
Office	25
Canteen, Restaurant, Hotel	26
Laboratory	27
Institution	28
Laundry	29
Place of Entertainment	31
Mine	32
Lines of Communication, above ground (Stations, Depots, Signal Box, Railway Yards, Docks, etc.)	33
Lines of Communication, below ground	34
Outdoor (other than above).	35
B. *Temporary*	
Indoor	41
Outdoor	42
Mixed	40
C. *Mobile*	
On foot or cycle	51
Vehicle above ground	52
Vehicle below ground	53
Air transport	54
Water transport	55
D. *Other*	89
E. *Unspecified*	99

Locality is another headache, partly because of the diversity of area specifications (e.g. local government, food, electricity and gas, parliamentary) relevant to different administrative or other ends in view, and partly because many patients can supply no definite domiciliary information other than street and house number. At one time or another, one may need to know the educational authority responsible for a child, the accident hospital nearest to the home, the reservoir which provides its water supply. An address does not necessarily supply the information, since houses on opposite sides of a street may be in different county boroughs with a different water supply and a different educational budget. A grid is unworkable for the same reason; and much which would be of value to research (*e.g.* in connexion with blood-group donor distributions) will not be available on medical documents until the Post Office, Ministry of Town and Country Planning, and Ministry of Local Government get together to work out a national code for domiciliary specification. Meanwhile, as a *pis aller*, we ourselves use a code of our own based on the Local Food Office as stated on the patient's ration card. We should like to commend to the consideration of the Central Statistical Office the setting up of a National Co-ordination Committee on domiciliary, occupational, and industrial aspects of the coding problem.

Aside from the specialist knowledge which the construction of appropriate codes entails, the task is not one to dismiss lightly. Any sequence of numbers like those of the telephone directory will, of course, satisfy the requirements of a punch-card system, if the only end in view is to feed the information to the machine; but the proper design of a code should make the food digestible. As far as is practicable, this means that every cipher allocated to a column should be referable to some unique level of a taxonomical hierarchy. It is then possible to extract information of a particular type by a sort based on one column alone. For example, the 3-cipher sequence 001 to 456 suffices to accommodate all the 456 medical units (hospitals, clinics, sanatoria, convalescent homes, mental institutions, and colonies) of a particular region; but administrative requirements of one kind or another may call for information referable to medical units of a "Group" under the Act, to medical units situated within the boundaries of a particular unit of local government, to medical units with a particular type of accommodation (*e.g.* casualty department, beds for mental cases), and so forth. A 4-cipher or 5-cipher sequence for a designation otherwise adequately accommodated by three columns may therefore greatly assist us to coax the machine to deliver the data we want.

Two other considerations call for comment when it is necessary to call in an *ad hoc* code. One is that it may be possible to economize column space by incorporating information of more than one type in the same *niche*, as for instance sex and date of birth in the Personnel Specification Code of Hogben, Johnstone, and Cross (1948). The other issue worth mentioning is that a code for general use should be foolproof for the user, with respect both to explicit specification of the attribute and to its *niche* (column number or numbers) in the record. The following entry in the *Midland Region Medical Codes* of the United Birmingham Hospitals illustrates both desiderata. As for the foregoing occupation code the precise form of the column specification in the record itself appears above the instructions for coding:

Patient's Birth Rank (Code J) [ ]

Note.—If the individual is one of a pair of live-born twins or one of triplets, etc., it may not be possible to ascertain the actual *order of delivery*. When (and *only* when) unable to do so, count as the elder the one whose first name comes first alphabetically (*e.g.* Martha before Mary, and Jack before James).

Question	*Answer*	*Code No.*
Are you the first born child of your mother?	I don't know	0
	Yes	1
	No	(*see below*)
How many live-born children, living or deceased, had your mother before your birth?	I don't know	0
	One	2
	Two	3
	Three	4
	Four	5
	Five	6
	Six	7
	Seven	8
	Over Seven	9

A department which has constant use for recording data of a particular class may find the labour of preparing *ad hoc* codes worth while; but it is not a task to undertake lightly. A third approach to the problem of coding economically is therefore worthy of consideration. Where the record calls for the specification of cognate attributes, it may be possible and it is most straightforward to work with simple dichotomies and trichotomies laid out hierarchically as in the foregoing illustrations from an *Obstetric Record*. There is, however, a procedure which involves no difficulty and is, as far as we know, novel. Consider the following situation. The psychiatric field-worker wishes to record the patient's demeanour in an interview under the headings:

A. *insolent*, B. *aloof*, C. *excited*, D. *ingratiating*, E. *angry*, F. *listless*, G. *impatient*, H. *restless*, J. *normal*.

It goes without saying that this is not an exhaustive and exclusive classification, since a person may be insolent, angry, and excited in the same context. In fact the *n* attributes we are looking for in a given context may be such that an individual may have 0, 1, 2, 3 . . . or *n* of them. We can, of course, regard each with its opposite and doubtful as one item of an exhaustive exclusive set of three; but it would then be wasteful of column space to allocate one column to each. On the other hand, the entire assemblage constitutes an exhaustive and exclusive set of enumerable combinations, *viz:*

$$ {}^nC_0 + {}^nC_1 + {}^nC_2 \ldots\ldots + {}^nC_n = (1 + 1)^n = 2^n $$

Thus there will be at most 64 items of an exhaustive exclusive set of six attributes, and at most 512 of nine attributes, and 8,192 of thirteen attributes. This means that one 2-column code will suffice for five or six attributes, one 3-column code for seven, eight, or nine attributes, and one 4-column code for ten, eleven, twelve, or thirteen attributes. Thus we may lay out the appropriate record for the situation envisaged above for three consecutive columns (here 17–19):

17–19 Patient's Demeanour (*Ring appropriate letters*) [| | |] Universal 3-cipher code

A *insolent* D *ingratiating* G *impatient*
B *aloof* E *angry* H *restless*
C *excited* F *listless* J *normal*

The most simple plan for the construction of such a code is as follows for, say, five attributes A–E:

None		00	BC	*only*	10	BCD	*only*	22
A	*only*	01	BD	,,	11	BCE	,,	23
B	,,	02	BE	,,	12	BDE	,,	24
C	,,	03	CD	,,	13	CDE	,,	25
D	,,	04	CE	,,	14	ABCD	,,	26
E	,,	05	DE	,,	15	ABCE	,,	27
AB	,,	06	ABC	,,	16	ABDE	,,	28
AC	,,	07	ABD	,,	17	ACDE	,,	29
AD	,,	08	ABE	,,	18	BCDE	,,	30
AE	,,	09	ACD	,,	19	ABCDE	,,	31
			ACE	,,	20			
			ADE	,,	21			

The instructions for the sort whether by hand or machine will then be:

None 00
all A 01, 06–09, 16–21, 26–29, 31
all B 02, 06, 10–12, 16–18, 22–24, 26–28, 30–31,
etc.
all AB 06, 16–18, 26–28, 31 *all* ABC 16, 26–27, 31
all DE 15, 21, 24–25, 28–31 *all* BCD 22, 26, 30–31
etc. etc.
all ABCD 26, 31 *all* ABCDE 31
all BCDE 30–31, *all* Singles 01–05
etc. *all* Doubles 06–15
all Triplets 16–25
all Quadruplets 26–30

If the combinations and code numbers are laid out according to the foregoing sequential plan it is easy to check the list.

Let $S_r = ({}^nC_0 + {}^nC_1 + {}^nC_2 \ldots {}^nC_r)$.

Then we shall assign:

None 0; *Singles* $S_0 \ldots (S_1 - 1)$; *Doubles* $S_1 \ldots (S_2 - 1)$

and generally for r-fold combinations from

$$S_{r-1} \ldots (S_r - 1).$$

Such a code embraces a taxonomy which is exclusive and exhaustive, allowing for the possibility that an individual might have none of the attributes A–E or that he might have all of them. Since the specification of the meaning of A, B . . . *etc.* is explicit on the record, one code like the above will suffice for any set of n attributes, regardless of their designation in a particular niche. Hence we may speak of a code of this type as a universal code. This does not mean that it overrides the need for an *ad hoc* code when the number of attributes is larger than, say, three. Its special usefulness will be for situations in which a set of cognate attributes is neither exclusive nor exhaustive. For the convenience of others we here append two codes, one for five or six attributes, and one for seven, eight, or nine attributes. We have prepared for use a 4-column code for ten to thirteen attributes, but it is too bulky to include here.

For samples of complete pre-designed medical documents, we refer the reader to the recent publication of Hogben and Sim (1953).

REFERENCES

Hogben, L. (1951). *Incorporated Statistician*, **2**, No. 2, p. 2.
——, and Cross, K. W. (1948). *British Journal of Social Medicine*, **2**, 149.
——, Johnstone, M. M., and Cross, K. W. (1948). *Brit. med. J.*, **1**, 632.
—— and Sim, M. (1953). *British Journal of Preventive and Social Medicine*, **7**, 163.
——, Worrall, R. L., and Zieve, I. (1932). *Proc. Roy. Soc. Edinb.*, **52**, 264.

APPENDIX

Code I

Attributes: ABCDEF

None	00	AF	11	ABC	22	BCE	33	ABCF	44	BDEF	55
A	01	BC	12	ABD	23	BCF	34	ABDE	45	CDEF	56
B	02	BD	13	ABE	24	BDE	35	ABDF	46	ABCDE	57
C	03	BE	14	ABF	25	BDF	36	ABEF	47	ABCDF	58
D	04	BF	15	ACD	26	BEF	37	ACDE	48	ABCEF	59
E	05	CD	16	ACE	27	CDE	38	ACDF	49	ABDEF	60
F	06	CE	17	ACF	28	CDF	39	ACEF	50	ACDEF	61
AB	07	CF	18	ADE	29	CEF	40	ADEF	51	BCDEF	62
AC	08	DE	19	ADF	30	DEF	41	BCDE	52	ABCDEF	63
AD	09	DF	20	AEF	31	ABCD	42	BCDF	53		
AE	10	EF	21	BCD	32	ABCE	43	BCEF	54		

Code II

Attributes: ABCDEFLMN

None	000	DF	032	AEF	064	CDF	096	FMN	128	ACFL	160
A	001	DL	033	AEL	065	CDL	097	LMN	129	ACFM	161
B	002	DM	034	AEM	066	CDM	098	ABCD	130	ACFN	162
C	003	DN	035	AEN	067	CDN	099	ABCE	131	ACLM	163
D	004	EF	036	AFL	068	CEF	100	ABCF	132	ACLN	164
E	005	EL	037	AFM	069	CEL	101	ABCL	133	ACMN	165
F	006	EM	038	AFN	070	CEM	102	ABCM	134	ADEF	166
L	007	EN	039	ALM	071	CEN	103	ABCN	135	ADEL	167
M	008	FL	040	ALN	072	CFL	104	ABDE	136	ADEM	168
N	009	FM	041	AMN	073	CFM	105	ABDF	137	ADEN	169
AB	010	FN	042	BCD	074	CFN	106	ABDL	138	ADFL	170
AC	011	LM	043	BCE	075	CLM	107	ABDM	139	ADFM	171
AD	012	LN	044	BCF	076	CLN	108	ABDN	140	ADFN	172
AE	013	MN	045	BCL	077	CMN	109	ABEF	141	ADLM	173
AF	014	ABC	046	BCM	078	DEF	110	ABEL	142	ADLN	174
AL	015	ABD	047	BCN	079	DEL	111	ABEM	143	ADMN	175
AM	016	ABE	048	BDE	080	DEM	112	ABEN	144	AEFL	176
AN	017	ABF	049	BDF	081	DEN	113	ABFL	145	AEFM	177
BC	018	ABL	050	BDL	082	DFL	114	ABFM	146	AEFN	178
BD	019	ABM	051	BDM	083	DFM	115	ABFN	147	AELM	179
BE	020	ABN	052	BDN	084	DFN	116	ABLM	148	AELN	180
BF	021	ACD	053	BEF	085	DLM	117	ABLN	149	AEMN	181
BL	022	ACE	054	BEL	086	DLN	118	ABMN	150	AFLM	182
BM	023	ACF	055	BEM	087	DMN	119	ACDE	151	AFLN	183
BN	024	ACL	056	BEN	088	EFL	120	ACDF	152	AFMN	184
CD	025	ACM	057	BFL	089	EFM	121	ACDL	153	ALMN	185
CE	026	ACN	058	BFM	090	EFN	122	ACDM	154	BCDE	186
CF	027	ADE	059	BFN	091	ELM	123	ACDN	155	BCDF	187
CL	028	ADF	060	BLM	092	ELN	124	ACEF	156	BCDL	188
CM	029	ADL	061	BLN	093	EMN	125	ACEL	157	BCDM	189
CN	030	ADM	062	BMN	094	FLM	126	ACEM	158	BCDN	190
DE	031	ADN	063	CDE	095	FLN	127	ACEN	159	BCEF	191

APPENDIX—*contd.*

CODE II—*contd.*

BCEL .. 192
BCEM .. 193
BCEN.. .. 194
BCFL .. 195
BCFM .. 196
BCFN.. .. 197
BCLM .. 198
BCLN.. .. 199
BCMN .. 200
BDEF .. 201
BDEL .. 202
BDEM .. 203
BDEN .. 204
BDFL .. 205
BDFM .. 206
BDFN .. 207
BDLM .. 208
BDLN .. 209
BDMN .. 210
BEFL .. 211
BEFM .. 212
BEFN .. 213
BELM .. 214
BELN .. 215
BEMN .. 216
BFLM .. 217
BFLN .. 218
BFMN .. 219
BLMN .. 220
CDEF.. .. 221
CDEL.. .. 222
CDEM .. 223
CDEN .. 224
CDFL.. .. 225
CDFM .. 226
CDFN .. 227
CDLM .. 228
CDLN .. 229
CDMN .. 230
CEFL .. 231
CEFM .. 232
CEFN.. .. 233
CELM .. 234
CELN.. .. 235
CEMN .. 236
CFLM .. 237
CFLN.. .. 238
CFMN .. 239
CLMN .. 240
DEFL .. 241
DEFM .. 242
DEFN .. 243
DELM .. 244
DELN .. 245
DEMN .. 246
DFLM .. 247
DFLN .. 248
DFMN .. 249
DLMN .. 250
EFLM .. 251
EFLN .. 252
EFMN .. 253
ELMN .. 254
FLMN .. 255
ABCDE .. 256
ABCDF .. 257
ABCDL .. 258
ABCDM .. 259
ABCDN .. 260
ABCEF .. 261
ABCEL .. 262
ABCEM .. 263
ABCEN .. 264
ABCFL .. 265
ABCFM .. 266
ABCFN .. 267
ABCLM .. 268
ABCLN .. 269
ABCMN .. 270
ABDEF .. 271
ABDEL .. 272
ABDEM .. 273
ABDEN .. 274
ABDFL .. 275
ABDFM .. 276
ABDFN .. 277
ABDLM .. 278
ABDLN .. 279
ABDMN .. 280
ABEFL .. 281
ABEFM .. 282
ABEFN .. 283
ABELM .. 284
ABELN .. 285
ABEMN .. 286
ABFLM .. 287
ABFLN .. 288
ABFMN .. 289
ABLMN .. 290
ACDEF .. 291
ACDEL .. 292
ACDEM .. 293
ACDEN .. 294
ACDFL .. 295
ACDFM .. 296
ACDFN .. 297
ACDLM .. 298
ACDLN .. 299
ACDMN .. 300
ACEFL .. 301
ACEFM .. 302
ACEFN .. 303
ACELM .. 304
ACELN .. 305
ACEMN .. 306
ACFLM .. 307
ACFLN .. 308
ACFMN .. 309
ACLMN .. 310
ADEFL .. 311
ADEFM .. 312
ADEFN .. 313
ADELM .. 314
ADELN .. 315
ADEMN .. 316
ADFLM .. 317
ADFLN .. 318
ADFMN .. 319
ADLMN .. 320
AEFLM .. 321
AEFLN .. 322
AEFMN .. 323
AELMN .. 324
AFLMN .. 325
BCDEF .. 326
BCDEL .. 327
BCDEM .. 328
BCDEN .. 329
BCDFL .. 330
BCDFM .. 331
BCDFN .. 332
BCDLM .. 333
BCDLN .. 334
BCDMN .. 335
BCEFL .. 336
BCEFM .. 337
BCEFN .. 338
BCELM .. 339
BCELN .. 340
BCEMN .. 341
BCFLM .. 342
BCFLN .. 343
BCFMN .. 344
BCLMN .. 345
BDEFL .. 346
BDEFM .. 347
BDEFN .. 348
BDELM .. 349
BDELN .. 350
BDEMN .. 351
BDFLM .. 352
BDFLN .. 353
BDFMN .. 354
BDLMN .. 355
BEFLM .. 356
BEFLN .. 357
BEFMN .. 358
BELMN .. 359
BFLMN .. 360
CDEFL .. 361
CDEFM .. 362
CDEFN .. 363
CDELM .. 364
CDELN .. 365
CDEMN .. 366
CDFLM .. 367
CDFLN .. 368
CDFMN .. 369
CDLMN .. 370
CEFLM .. 371
CEFLN .. 372
CEFMN .. 373
CELMN .. 374
CFLMN .. 375
DEFLM .. 376
DEFLN .. 377
DEFMN .. 378
DELMN .. 379
DFLMN .. 380
EFLMN .. 381
ABCDEF .. 382
ABCDEL .. 383
ABCDEM .. 384
ABCDEN .. 385
ABCDFL .. 386
ABCDFM .. 387
ABCDFN .. 388
ABCDLM .. 389
ABCDLN .. 390
ABCDMN .. 391
ABCEFL .. 392
ABCEFM .. 393
ABCEFN .. 394
ABCELM .. 395
ABCELN .. 396
ABCEMN .. 397
ABCFLM .. 398
ABCFLN .. 399
ABCFMN .. 400
ABCLMN .. 401
ABDEFL .. 402
ABDEFM .. 403
ABDEFN .. 404
ABDELM .. 405
ABDELN .. 406
ABDEMN .. 407
ABDFLM .. 408
ABDFLN .. 409
ABDFMN .. 410
ABDLMN .. 411
ABEFLM .. 412
ABEFLN .. 413
ABEFMN .. 414
ABELMN .. 415
ABFLMN .. 416
ACDEFL .. 417
ACDEFM .. 418
ACDEFN .. 419
ACDELM .. 420
ACDELN .. 421
ACDEMN .. 422
ACDFLM .. 423
ACDFLN .. 424
ACDFMN .. 425
ACDLMN .. 426
ACEFLM .. 427
ACEFLN .. 428
ACEFMN .. 429
ACELMN .. 430
ACFLMN .. 431
ADEFLM .. 432
ADEFLN .. 433
ADEFMN .. 434
ADELMN .. 435
ADFLMN .. 436
AEFLMN .. 437
BCDEFL .. 438
BCDEFM .. 439
BCDEFN .. 440
BCDELM .. 441
BCDELN .. 442
BCDEMN .. 443
BCDFLM .. 444
BCDFLN .. 445
BCDFMN .. 446
BCDLMN .. 447
BCEFLM .. 448
BCEFLN .. 449
BCEFMN .. 450
BCELMN .. 451
BCFLMN .. 452
BDEFLM .. 453
BDEFLN .. 454
BDEFMN .. 455
BDELMN .. 456
BDFLMN .. 457
BEFLMN .. 458
CDEFLM .. 459
CDEFLN .. 460
CDEFMN .. 461
CDELMN .. 462
CDFLMN .. 463
CEFLMN .. 464
DEFLMN .. 465
ABCDEFL .. 466
ABCDEFM .. 467
ABCDEFN .. 468
ABCDELM .. 469
ABCDELN .. 470
ABCDEMN .. 471
ABCDFLM .. 472
ABCDFLN .. 473
ABCDFMN .. 474
ABCDLMN .. 475
ABCEFLM .. 476
ABCEFLN .. 477
ABCEFMN .. 478
ABCELMN .. 479
ABCFLMN .. 480
ABDEFLM .. 481
ABDEFLN .. 482
ABDEFMN .. 483
ABDELMN .. 484
ABDFLMN .. 485
ABEFLMN .. 886
ACDEFLM .. 487
ACDEFLN .. 488
ACDEFMN .. 489
ACDELMN .. 490
ACDFLMN .. 491
ACEFLMN .. 492
ADEFLMN .. 493
BCDEFLM .. 494
BCDEFLN .. 495
BCDEFMN .. 496
BCDELMN .. 497
BCDFLMN .. 498
BCEFLMN .. 499
BDEFLMN .. 500
CDEFLMN .. 501
ABCDEFLM 502
ABCDEFLN 503
ABCDEFMN 504
ABCDELMN 505
ABCDFLMN 506
ABCEFLMN 507
ABDEFLMN 508
ACDEFLMN 509
BCDEFLMN 510
ABCDEFLMN 511

Brit. J. prev. soc. Med. (1954), **8**, 17–23

INCIDENCE OF ANENCEPHALUS, SPINA BIFIDA, AND HYDROCEPHALUS RELATED TO BIRTH RANK AND MATERNAL AGE*

BY

THEODORE H. INGALLS, THOMAS F. PUGH, AND BRIAN MACMAHON†

From the Department of Epidemiology, Harvard University School of Public Health, Boston, Mass., U.S.A.

INTRODUCTION

Several investigators have stressed the importance of genetic factors in the aetiology of malformations of the central nervous system, and some have even advanced hypotheses describing the genetic mechanisms involved. Such hypotheses are speculative, and the role of environmental events should continue to receive evaluation.

Association of characteristics of the offspring with birth order or with maternal age is provisional evidence of the operation of environmental influences in causation; in addition, such data may provide clues for the elucidation of the more specific environments involved. The weight of previously published evidence relating congenital malformations of the central nervous system to birth rank and maternal age suggests that both variables influence the occurrence of these anomalies. Penrose (1946), using a modification of the Greenwood-Yule method, found an increasing frequency of a group of central nervous malformations (anencephalus, spina bifida, and hydrocephalus) with advancing maternal age. After correction for the effect of maternal age, occurrence was somewhat excessive in the first birth rank and at birth ranks 7 and over. Malpas (1937) analysed the distribution of anencephaly (44 cases among 13,964 deliveries) according to maternal age, and found the defect to occur about ten times more frequently in the age group 46–50 than in the age group 16–20. Böök and Rayner (1950) surveyed the protocols of 67 cases of anencephaly without finding any significant relation of the defect to advancing age or birth rank. Schwidde (1952) and Polman (1950) have also reported negative findings. Büchi (1950) identified 2,922 malformed infants among some 160,000 births in Copenhagen, and noted increasing frequency of hydrocephalus, spina bifida, and anencephalus with increasing maternal age. A similar investigation by Hegnauer (1951) confirmed these relationships for hydrocephalus and anencephalus, although no association was observed between maternal age and spina bifida.

Record and McKeown (1949), presenting the largest material to date, compared stillbirths and infant deaths attributed to malformations of the central nervous system in Birmingham, England, with a sample of births in the general population. In their material, the effect of maternal age on anencephalus and spina bifida was slight when compared with the influence of birth order, incidence being relatively high in first births and in births after the sixth; the effect of birth order on hydrocephalus was slight compared with the marked increase with advancing maternal age.

MATERIAL

This study is concerned with all cases of anencephalus, spina bifida, and hydrocephalus recorded as having been delivered in the five large maternity units in the state of Rhode Island, U.S.A. during the years 1936–52. The percentage of births in the state which have occurred in these five units has increased over the period from 63·7 in 1936 to 74·4 in 1949, the latest year for which figures are at hand. Over the whole period 1936–49, 67 per cent. of births in the state occurred in these hospitals. While it is a reasonable assumption that a patient with anticipated complications would be more likely to be delivered in one of these five hospitals than elsewhere in the state, their number is so diluted with normal deliveries that we believe the births occurring in these hospitals are reasonably representative of births in the central and northern sections of the state.

A comparison series was assembled by taking every one hundredth name from the delivery-room registers, which list confinements chronologically, for the same hospitals over the same period of time (1936–52), and by obtaining information on maternal age and parity from case records.

* Supported by a grant from the Association for the Aid of Crippled Children, New York.

† In receipt of a Rockefeller Foundation fellowship.

TABLE I

PERCENTAGE DISTRIBUTION BY BIRTH RANK AND MATERNAL AGE OF COMPARISON GROUP, 1939–49 (1,111), AND ALL LIVEBIRTHS TO RESIDENTS OF RHODE ISLAND, 1939–49 (151,977)

Maternal Age	Birth Rank					
	1	2	3	4	5 and over	Total
Under 20	4·95 (4·68)	0·72 (0·78)	— (0·01)	— (0·01)	— —	5·67 (5·57)
20–24 ..	18·81 (18·01)	7·38 (7·96)	1·62 (2·33)	0·54 (0·64)	— (0·24)	28·35 (29·19)
25–29 ..	12·87 (12·52)	11·88 (11·21)	4·50 (4·95)	1·35 (1·99)	1·44 (1·51)	32·04 (32·18)
30–34 ..	5·94 (4·86)	8·10 (6·61)	4·95 (4·40)	2·34 (2·20)	2·25 (2·62)	23·58 (20·70)
35 and over	1·17 (1·83)	2·97 (2·56)	2·52 (2·40)	1·26 (1·70)	2·43 (3·86)	10·35 (12·36)
Total ..	43·74 (41·90)	31·05 (29·12)	13·59 (14·19)	5·49 (6·55)	6·12 (8·24)	100·0 (100·0)

Data for all residents of Rhode Island in brackets.

Table I gives the percentage distribution by birth rank and maternal age of livebirths in the comparison group, and of livebirths (151,977) to residents of Rhode Island occurring in the state during 1939–49, the years for which data are available from national vital statistics. Differences between the two distributions are small and support the belief that the comparison series is reasonably representative of births in the general population of Rhode Island.

BIRTH RANK AND MATERNAL AGE

Tables II and III compare the percentage distributions of the malformation and comparison series by birth rank and maternal age respectively. "Birth Rank" is calculated as the number of "viable" pregnancies; multiple births are counted once, and foetal deaths delivered before 5 completed months of gestation are excluded.

The grouped findings are in some respects similar to those reported by Record and McKeown (1949); an excess of malformations was found in first births and in birth ranks after the fifth, the percentage

TABLE II

PERCENTAGE DISTRIBUTION OF MALFORMATIONS AND COMPARISON GROUP BY BIRTH RANK

Birth Rank	Anencephalus		Spina Bifida		Hydrocephalus		All Malformations (*a*)		Comparison Group (*b*)		Difference (*a*) − (*b*)
	No.	%	No.	%	No.	%	No.	%	No.	%	
1	150	46·30	201	47·74	68	44·74	419	46·71	699	42·26	+4·45±2·06*
2	87	26·85	106	25·18	34	22·37	227	25·31	509	30·77	−5·46±1·88*
3	42	12·96	57	13·54	20	13·16	119	13·27	233	14·09	−0·82±1·43
4 and 5	28	8·64	39	9·26	22	14·47	89	9·92	152	9·19	+0·73±1·21
6 and over ..	17	5·25	18	4·28	8	5·26	43	4·79	61	3·69	+1·10±0·82
Total	324	100·0	421	100·0	152	100·0	897	100·0	1,654	100·0	—

Birth rank was unknown for two anencephalics, five cases of spina bifida, and sixteen comparison patients.

* Difference exceeds twice its standard error.

TABLE III

PERCENTAGE DISTRIBUTION OF MALFORMATIONS AND COMPARISON GROUP BY MATERNAL AGE

Maternal Age	Anencephalus		Spina Bifida		Hydrocephalus		All Malformations (*a*)		Comparison Group (*b*)		Difference (*a*) − (*b*)
	No.	%	No.	%	No.	%	No.	%	No.	%	
Under 20 ..	21	6·48	20	4·75	2	1·32	43	4·79	84	5·08	−0·29±0·90
20–24	85	26·23	103	24·47	45	29·61	233	25·97	479	28·96	−2·99±1·86
25–29	110	33·95	147	34·92	39	25·66	296	33·00	519	31·38	+1·62±1·93
30–34	66	20·37	88	20·90	30	19·74	184	20·51	386	23·34	−2·83±1·73
35–39	31	9·57	46	10·93	29	19·08	106	11·82	156	9·43	+2·39±1·26
40 and over ..	11	3·40	17	4·04	7	4·61	35	3·90	30	1·81	+2·09±0·65*
Total	324	100·0	421	100·0	152	100·0	897	100·0	1,654	100·0	—

* Difference exceeds twice its standard error.

relative to the comparison group being lowest in second births (Table II). These differences are, however, less marked than those noted in Birmingham, particularly in the excess of malformations in the later birth ranks, an excess which is not significant in the present series. For the three malformations grouped, a significant excess of anomalies is observed at high maternal ages (Table III).

The Tables also show the percentage distributions by age and parity of mothers for each of the three main subdivisions of central nervous system anomalies. Anencephalus with spina bifida is classed as "anencephalus", and encephalocele or spina bifida with hydrocephalus as "spina bifida". We have previously shown that sex ratios of individual malformations do not contraindicate these groupings (MacMahon, Pugh, and Ingalls, 1953). We have also examined maternal age and birth order association separately for each of these five diagnoses and found no appreciable differences between anencephalus and anencephalus with spina bifida, or between spina bifida, spina bifida with hydrocephalus, and encephalocele. The small numbers involved in a finer subdivision, and the desirability of presenting material comparable to that previously published by others, are further reasons for adopting these groupings.

The excess of first births (Table II) is found to be mainly the result of excesses in the anencephalus and spina bifida groups, while the excess at high maternal ages (Table III) occurs almost entirely in the group of hydrocephalic infants. The percentage of mothers aged 35 years and over in the hydrocephalic group is 23·7, which differs from the corresponding percentage for the comparison group (11·2) by $12{\cdot}4 \pm 2{\cdot}8$ per cent.

In Tables IV, V, and VI, trends with age and parity are examined separately for the three diagnoses by calculating incidence according to age and parity simultaneously. The assumption is made that all births (168,654) recorded in the five hospitals over the period of the inquiry are distributed by age and parity according to the distribution of the 1,654 mothers in the comparison group for whom age and parity were known.

The results are as might be expected from the data presented in Tables II and III. For both anencephalus (Table IV) and spina bifida (Table V) the main variation is in association with birth order.

TABLE IV

INCIDENCE OF ANENCEPHALUS PER 1,000 TOTAL BIRTHS RELATED TO BIRTH RANK AND MATERNAL AGE

Maternal Age	Birth Rank											
	1		2		3		4 and 5		6 and over		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Under 20	18	2·56	3	2·10	—	—	—	—	—	—	21	2·45
20–24	58	1·81	22	1·78	2	0·58	2	—	1	—	85	1·74
25–29	47	2·32	35	1·78	19	2·62	7	1·49	2	1·96	110	2·08
30–34	20	2·16	20	1·45	13	1·61	9	1·50	4	1·78	66	1·68
35 and over	7	2·64	7	1·49	8	1·63	10	2·58	10	3·50	42	2·21
Total	150	2·10	87	1·68	42	1·77	28	1·81	17	2·73	324	1·92

No estimates are given for cells containing less than 1,000 total births.

TABLE V

INCIDENCE OF SPINA BIFIDA PER 1,000 TOTAL BIRTHS RELATED TO BIRTH RANK AND MATERNAL AGE

Maternal Age	Birth Rank											
	1		2		3		4 and 5		6 and over		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Under 20	17	2·42	3	2·10	—	—	—	—	—	—	20	2·33
20–24	76	2·37	22	1·78	4	1·15	1	—	—	—	103	2·11
25–29	65	3·20	42	2·13	27	3·73	11	2·34	2	1·96	147	2·78
30–34	29	3·13	24	1·74	18	2·23	14	2·33	3	4·99	88	2·24
35 and over	14	5·28	15	3·20	8	1·63	13	3·35	13	4·55	63	3·32
Total	201	2·82	106	2·04	57	2·31	39	2·52	18	2·89	421	2·50

TABLE VI

INCIDENCE OF HYDROCEPHALUS PER 1,000 TOTAL BIRTHS RELATED TO BIRTH RANK AND MATERNAL AGE

Maternal Age	Birth Rank											
	1		2		3		4 and 5		6 and over		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Under 20	1	0·14	1	0·70	—	—	—	—	—	—	2	0·23
20–24	31	0·97	10	0·81	3	0·87	1	—	—	—	45	0·92
25–29	14	0·69	14	0·72	6	0·83	5	1·07	—	—	39	0·74
30–34	10	1·08	5	0·36	7	0·87	7	1·16	1	0·45	30	0·76
35 and over	12	4·53	4	0·85	4	0·82	9	2·32	7	2·45	36	1·90
Total	68	0·95	34	0·66	20	0·84	22	1·42	8	1·29	152	0·90

Incidence is high in first births, falls to its lowest level in second births, and then increases with increasing birth rank. Considering the small numbers involved, this trend is reasonably regular within each maternal age group. At the same time, incidence also varies, but to a lesser degree, with maternal age. Both in individual birth ranks and in the total for all birth ranks, there is a tendency for incidence, especially that of spina bifida, to be highest in the youngest and oldest mothers. The high incidence of spina bifida in first births at ages 35 and over is noteworthy. The reverse is found for hydrocephalus (Table VI), where the main variation is in association with maternal age, but where there is nevertheless a tendency for incidence to be highest in first and in fourth and later births. Here again the high incidence (five times the average incidence) in first births at ages 35 and over is noticeable. However, the data on hydrocephalus should be interpreted with caution, since criteria of diagnosis of this malformation lack clarity. Difficult labour is known to be more common at high maternal ages, particularly in primiparae, and it is conceivable that the diagnosis of hydrocephalus is made more frequently in difficult than in normal deliveries. To test this possibility, the 31 most severe cases were analysed separately, and in only four (13 per cent.) of them were the mothers aged 35 years or older. These numbers are admittedly small, but there appears to be little association with maternal age for this severe group.

FAMILY SIZE

Maternal fertility is an important consideration wherever an association with birth order or maternal age has been demonstrated. Available data permit only a limited consideration of family size, since dates of birth of previous siblings were available for only a small number of propositi.

The largest hospital from which our material is drawn (accounting for 53·1 per cent. of the malformation propositi and 52·5 per cent. of the controls) maintains a unit record system in which records for all admissions of each patient are included in one file. Available therefore, for mothers of malformation and control propositi born in that hospital, are the numbers of infants born subsequently in the same hospital (Table VII). The Table is limited to first-born propositi and siblings born subsequently until 1st October, 1952; propositi born in 1952 are excluded since none had siblings born in that year.

TABLE VII

PERCENTAGE DISTRIBUTION ACCORDING TO NUMBER OF SUBSEQUENT SIBLINGS BORN IN THE SAME HOSPITAL

Group	Number of Subsequent Siblings										Total		Mean No. of Siblings
	0		1		2		3		4				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Anencephalus	31	41·3	24	32·0	14	18·7	5	6·7	1	1·3	75	100·0	1·08
Spina Bifida	40	41·7	28	29·2	17	17·7	8	8·3	3	3·1	96	100·0	1·03
Hydrocephalus	14	45·2	11	35·5	5	16·1	1	3·2	—	—	31	100·0	0·77
All Malformations	85	42·1	63	31·2	36	17·8	14	6·9	4	2·0	202	100·0	0·96
Control group	180	54·1	114	34·2	22	6·6	13	3·9	4	1·2	333	100·0	0·64

Comparing all malformations with controls (grouping 3 and 4): $\chi^2 = 21{\cdot}37$, $n = 3$, $p < 0{\cdot}01$.

Table, based on firstborn propositi in one hospital, 1936–51, refers to subsequent siblings born before October 1, 1952.

The data suggest that mothers of malformed children have more children subsequently than mothers of normal children, but this cannot be inferred with confidence since the total family structure remains unverified. Nevertheless, it seems reasonable to suppose that at least a part of the excess of children born to mothers of malformations may be explained by a greater desire for subsequent children when the first is dead or grossly deformed. Such evidence as we have, therefore, indicates no limitation of family size following a firstborn child with one of the central nervous system anomalies considered here, and the low incidence of anencephalus and spina bifida in births immediately following the first is not explainable on the basis of such limitation. Record and McKeown (1950) found no significant difference in fertility between mothers of malformed infants and mothers of control infants.

During the course of the inquiry, positive statements of maternal illnesses appearing on the obstetric case records of mothers of malformed infants were noted; such data are of wholly speculative value, since completeness of recording of such events is not known: no instance of rubella was recorded; three mothers had appendectomy during pregnancy, two in the first trimester and one on an unrecorded date; two had bicornuate uteri and one a septate vagina; four had placenta praevia; one had measles in the first month of pregnancy; and a diabetic mother gave birth to two successive macerated foetuses with hydrocephalus and a third child suspected of having congenital heart disease. Such observations must be viewed against the background of the 904 births among which they occurred. No significance can be attached to them in the absence of an unbiased search for similar events in the control group. None the less, they are worthy of record, since congenital anencephalus, spina bifida, and hydrocephalus have been induced experimentally of late years by such diverse environmental insults to the mother as roentgen irradiation (Russell, 1950), vitamin deficiencies (Warkany, 1945), trypan-blue intoxication (Gillman and others, 1948), or anoxia (Ingalls and others, 1950).

Discussion

The results of this investigation are in general agreement with those of Record and McKeown carried out in Birmingham, England. It is of interest, however, to speculate on certain differences in the findings of the two series, and on how these may have arisen. The association between hydrocephalus and maternal age is similar in both studies, but the association of birth order with anencephalus and spina bifida, while similar in trend, is less marked in the Rhode Island data.

The Rhode Island series has advantages in respect of accuracy of diagnosis and completeness of information on birth order and maternal age since the source of clinical information at Birmingham was death certificates. On the other hand, the Birmingham study has advantages in that it was not limited to hospital deliveries. All the implications of these selective features are not clear, but certain obvious factors may have contributed to the differences noted.

For example, the percentage of first births in our comparison group is slightly higher than that in all livebirths to residents of Rhode Island (Table I). The difference is small and not significant ($1 \cdot 84 \pm 1 \cdot 48$) but is nevertheless fairly constant throughout the period covered, and it seems reasonable to believe that a hospital population may be selected in favour of first births. On the other hand, births involving malformed infants, in common with other difficult or abnormal labours, may not be selected for parity to the same degree, and may be more representative of the population as a whole. This would tend to lower the incidence of malformations in hospital first births. If this were true the influence would be small, since the effect of using the Rhode Island livebirth figures instead of the hospital control population would be to raise the incidence of anencephalus in first births from 2·10 to 2·12 per cent., and of spina bifida from 2·82 to 2·84 per cent. More likely the difference between the comparison group and Rhode Island live births results from the absence of stillbirths, known to be commoner in first births, in the latter group. We have no information on survival for the hospital comparison group or on stillbirths for Rhode Island residents, and therefore cannot make a direct comparison.

Another feature of selection which probably influences the lower incidence of malformations observed in first births in Rhode Island is the relationship between duration of gestation and probability of being delivered in hospital. Duration of the gestation terminating in the birth of an infant with anencephalus is not given in the Birmingham series for the years of the age and parity inquiry, but is given in another communication for a somewhat longer period (MacMahon and McKeown, 1952). These data are reproduced in Table VIII (overleaf), with similar figures for Rhode Island. There are significantly fewer anencephalics of short gestation in the Rhode Island series. Anencephalics of short gestation are more commonly first born than are those of later gestation (MacMahon and McKeown, 1952), and a deficiency of early gestations

TABLE VIII

PERCENTAGE DISTRIBUTION OF CASES OF ANENCEPHALUS BY DURATION OF GESTATION FOR BIRMINGHAM (1940–51)* AND RHODE ISLAND (1936–52)

Investigation	Duration of Gestation (wks)						Total	
	Under 33		33–37		38 and over			
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Birmingham	139	29·3	194	40·8	142	29·9	475	100·0
Rhode Island	69	22·6	130	42·6	106	34·8	305†	100·0
Difference		6·7±3·2		1·8±3·6		4·9±3·4		—

*Data from MacMahon and McKeown (1952).
†Duration of gestation not known for 21 anencephalic births.

TABLE IX

PERCENTAGE DISTRIBUTION OF ANENCEPHALICS BY BIRTH RANK ACCORDING TO DURATION OF GESTATION FOR BIRMINGHAM (1940–51)*, and RHODE ISLAND (1936–52).

Investigation	Birth Rank	Anencephalus Duration of Gestation (wks)				Comparison Group†
		Under 33	33–37	38 and over	Total	
Birmingham	1	66·9	51·8	35·5	51·4	34·0
	2	16·5	22·3	24·8	21·4	29·8
	3	6·5	8·3	14·9	9·7	15·0
	4 and over	10·1	17·6	24·8	17·5	21·3
	Total ..	100 (139)	100 (193)	100 (141)	100 (473)	100‡ (742)
Rhode Island	1	59·4	42·3	43·4	46·6	42·3
	2	18·8	29·2	28·3	26·6	30·8
	3	10·1	13·8	13·2	12·8	14·1
	4 and over	11·6	14·6	15·1	14·1	12·9
	Total ..	100 (69)	100 (130)	100 (106)	100 (305)	100 (1,654)

*Data from MacMahon and McKeown (1952).
†Data from Record and McKeown (1949). The years are not exactly comparable.
‡Actual numbers in brackets.

could therefore account for a low proportion of first births in the series. In this respect Table IX is of interest. If the inquiries had been confined to anencephalics of relatively long gestation (in Birmingham 38 weeks or over, in Rhode Island hospitals 33 weeks or over), no relationship between primiparity and anencephalus would have been found. As an explanation of the difference between the incidence in first births in the two series, this situation depends on a relationship between early onset of labour and domiciliary delivery. No such relationship was found for all births in Birmingham by Gibson and McKeown (1950), but this does not deny the possibility of its existence for anencephalics in Rhode Island. Such considerations do not apply to cases of spina bifida, in which early onset of labour is unusual.

Differences in the lengths of time covered in the two inquiries may also have contributed to the differences in birth order incidence. Both in Birmingham and in Rhode Island the incidence of anencephalus and spina bifida was appreciably lower during the late 1940s, than during the war years. While the Birmingham age and parity inquiry was limited to the years of highest incidence, the Rhode Island survey covered a wider period.

Table X (opposite) gives the incidence of anencephalus and spina bifida combined in 4-yearly periods. The secular change in incidence noted in our previous communication (MacMahon, Pugh, and Ingalls, 1953) was most marked in first births, with the consequence that difference in incidence between first and later births was most marked in the earlier years of the inquiry. In fact, for the period 1948–52, no increased incidence in first births is observed. This situation is seen for both anencephalus and spina bifida when these are examined separately. Thus, if the inquiry had not included the years 1948–52, the results would have indicated a greater excess of first births than that now noted.

None of these considerations accounts for the lower incidence in later birth ranks here noted

TABLE X

INCIDENCE OF ANENCEPHALUS AND SPINA BIFIDA COMBINED BY BIRTH ORDER IN FOUR YEARLY TIME PERIODS

Years	Birth Rank									
	1		2		3 and 4		5 and over		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1936–39	51	4·86	13	2·21	26	6·48	13	4·35	106	4·53
1940–43	93	5·92	55	5·56	28	5·28	12	5·35	191	5·76
1944–47	119	6·30	55	3·36	42	4·57	7	2·77	223	4·75
1948–52	88	3·37	70	3·56	48	3·31	25	5·21	232	3·57
Total	351	4·92	193	3·72	144	4·34	57	4·62	752*	4·46

*Includes seven cases of unknown birth order.

relative to the Birmingham study, and for this difference we have no explanation.

Interpretation of the meaning of these birth rank and maternal age associations is difficult. They may reasonably be regarded as evidence of the influence of environment in the aetiology of the conditions. The observation that the association between primiparity and anencephalus and spina bifida has been subject to secular change might suggest that the relationship has its explanation in the social and physical environment of the mother rather than in anatomic or physiological changes connected with birth order.

SUMMARY

Information on birth rank and maternal age is available for 324 cases of anencephalus, 421 cases of spina bifida, 152 hydrocephalics, and 1,654 comparison births occurring in the five large maternity units in the state of Rhode Island during the years 1936–52.

For anencephalus and spina bifida, incidence falls from Birthrank 1 to Birthrank 2, and then increases progressively with birth order. For hydrocephalus, incidence increases progressively with maternal age. Less marked associations are noted with birth order for hydrocephalus, and with maternal age for anencephalus and spina bifida.

For anencephalus, the high incidence in first births is limited to those of short gestation. For both anencephalus and spina bifida the association with primiparity is most marked in the early years of the study and is in fact non-existent in the period 1948–52. This is interpreted as evidence that the association with primiparity results from social or external environmental factors.

Data on maternal fertility are limited, but suggest that there is no family limitation following a first-born malformed infant.

We are indebted to the administrative and obstetric staffs of the Pawtucket Memorial, Providence Lying-In, Roger Williams General, St. Joseph's, and Woonsocket General Hospitals, who kindly gave access to their records.

We are particularly grateful for the encouragement of Drs. Harmon P. Jordon, Alfred L. Potter, Walter S. Jones, and John G. Walsh, and of Miss Gertrude Cahir, of the Providence Lying-In Hospital, where the study was begun.

REFERENCES

Böök, J. A., and Rayner, S. (1950). *Amer. J. hum. Genet.*, 2, 61.
Büchi, E. C. (1950). *Arch. Klaus-Stift. VererFborsch.*, 25, 61.
Gibson, J. R., and McKeown, T. (1950). *British Journal of Social Medicine*, 4, 221.
—— —— (1947).
Gillman, J., Gilbert, C., and Gillman, T. (1948). *S. Afr. J. med. Sci.*, 13, 47.
Hegnauer, H. (1951). *Geburts. u. Frauenheilk.*, 11, 777.
Ingalls, T. H., Curley, F. J., and Prindle, R. A. (1950). *Amer. J. Dis. Child.*, 80, 34.
MacMahon, B., and McKeown, T. (1952). *British Journal of Social Medicine*, 6, 265.
——, Pugh, T. F., and Ingalls, T. H. (1953). *British Journal of Preventive and Social Medicine*, 7, 211.
Malpas, P. (1937). *J. Obstet. Gynaec. Brit. Emp.*, 44, 434.
Penrose, L. S. (1946). *Ann. Eugen., Camb.*, 13, 73.
Polman, A. (1950). *Genetica*, 25, 29.
Record, R. G., and McKeown, T. (1949). *British Journal of Social Medicine*, 3, 183.
—— —— (1950). *Ibid.*, 4, 26.
Russell, L. B. (1950). *J. Exp. Zool.*, 114, 545.
Schwidde, J. T. (1952). *Amer. J. Dis. Child.*, 84, 35.
Warkany, J. (1945). *Vitam. and Horm.*, 3, 73.

Brit. J. prev. soc. Med. (1954), **8**, 24–28

INCIDENCE OF INFECTIOUS DISEASE IN THE FIRST THREE YEARS OF LIFE, RELATED TO SOCIAL CIRCUMSTANCES

BY

C. R. LOWE and THOMAS McKEOWN

From the Department of Social Medicine, University of Birmingham

The association between the incidence of morbidity in the first 2 years of life and social class (defined according to the occupation of the father) has been examined in two recent communications. Using data for Luton, Grundy (1949) reported no association between "social class" and morbidity; using data from a National sample, Douglas (1951) noted a consistent social gradient in the incidence of disease.

The results of these inquiries have evoked some discussion of differences, which are not in fact very great. Douglas's generalization about a social gradient in morbidity rested mainly on an association in the first 2 years of life between the incidence of lower respiratory infection and occupation of father. The Luton investigation has since been extended to cover the first 5 years (Dykes, Grundy, and Lewis-Faning, 1953), and it has been concluded that although there was no consistent association between "social class" and the incidence of illness, "the respiratory infections show an upward gradient for the first year of life". Data presented by these authors in their Tables indicate that a similar gradient existed for the first 2 years combined. What seems clear is that, in some parts of Great Britain at least, the relationship of "social class" with morbidity in infancy is not very striking, and the much sharper association with mortality must be attributed largely to differences in case-mortality.

But it by no means follows from this that the incidence of morbidity in infancy is no longer much affected by the environment. There are reasons for doubting whether in this context the occupation of the father provides a sufficiently sensitive index of social circumstances (much less of environment in general); the most important reason is perhaps that it takes no account of family size. Gibson and McKeown (1952) showed that infant mortality in Birmingham in 1947 was more sharply related to maternal age and birth rank than to the standard of housing in the wards in which infants were domiciled. These differences were almost wholly attributable to deaths from infectious disease; for example, among children of mothers aged less than 25 years, the incidence of death from infection between the second and twelfth months was under twenty (per 1,000 children alive at 1 month) in the first born, and over eighty in the fourth and later born.

The magnitude of the differences in mortality made it seem worth exploring the association between morbidity and maternal age and birth rank. Data for this purpose were obtained shortly before or after the third birthday from mothers of certain children born in Birmingham during 1947 (the selection of this sample has been described by Lowe and Gibson, 1953). Each mother was asked to provide details of her child's illnesses during the first 3 years of life, but attention is here restricted to specific infections of childhood, including pneumonia, diarrhoea and vomiting, and otitis media. Diarrhoea and vomiting are included only if a medical practitioner was consulted. Bronchitis and coryza are excluded.

Histories were recorded in respect of 1,782 children (77 per cent. of the original sample). In 39 cases data were incomplete, and the examination of morbidity which follows is based on 1,743 children.

TABLE I

NUMBER OF INFECTIOUS EPISODES (PER 100 CHILDREN) BY THE FIRST AND THIRD BIRTHDAYS

Ward Group	No. of Children at Risk	No. of Episodes per 100 Children			
		By First Birthday		By Third Birthday	
		No.	Per cent.	No.	Per cent.
I	708	254	35·9	762	107·6
II and III	1,035	311	30·0	1,052	101·6
Total	1,743	565	32·4	1,814	104·1

We may first note that, as in the two investigations referred to above, the incidence of infectious disease does not appear to be sharply related to social circumstances. Table I gives the number of infectious episodes (per 100 children) by the first and third birthdays, according to Ward Group.*

* As indicated by Gibson and McKeown, 1952, all births in the city in 1947 were assigned by place of domicile to one of three Ward Groups, identified essentially on the basis of the standard of housing.

In the examination which follows, Ward Group I (poorest standard of housing) is compared with Groups II and III combined. At each interval the incidence of infection is higher, but not very much higher, in Group I than it is in Groups II and III. On the other hand, mortality is much more sharply associated with Ward Group, the number of deaths from infection between 2 and 12 months being 19·6 (per 1,000 children alive at 1 month) in Group I, and 11·0 in Groups II and III combined.

Fig. 1 relates mortality, and Fig. 2 morbidity, to birth rank and Ward Group; morbidity is again recorded as the number of infectious episodes (per 100 children) during the first 3 years, numbers being too small to permit separate consideration of the first year. The incidence of both mortality and morbidity rises sharply with birth order; but while Ward Group differences in mortality are substantial at each birth rank, differences in morbidity, though consistent, are trivial.

In Figs 3 and 4 (opposite), Ward Groups are again separated, and the association with birth order is shown separately for the two maternal age groups, under 30 years, and 30 years and over.* It will be noted that both mortality and morbidity

(*a*) increase with increasing birth rank
(*b*) decrease with increasing maternal age.

The effect of separation by age and birth order has therefore been further to magnify differences, which even in morbidity are now substantial. For example, in Group I the incidence of infectious episodes is 66 in the first born children of mothers aged 30 and over, and 145 in the third and later born children of mothers under 30. The corresponding figures for Ward Groups II and III combined are 58 and 152 respectively, which indicates that by comparison with those related to age and birth order, differences associated with the standard of housing are trivial.

Although numbers of children with individual illnesses are rather small, they are large enough in the case of the more common infectious diseases to enable us to examine separately their association with the same variables. Table II gives the number of infectious episodes in the first 3 years attributed to measles, whooping cough, pneumonia, and diarrhoea and vomiting. The incidence of three of these diseases is a little higher in the Group with the poorest housing (Ward Group I) than in the other two; but in the case of whooping cough the relationship is reversed.

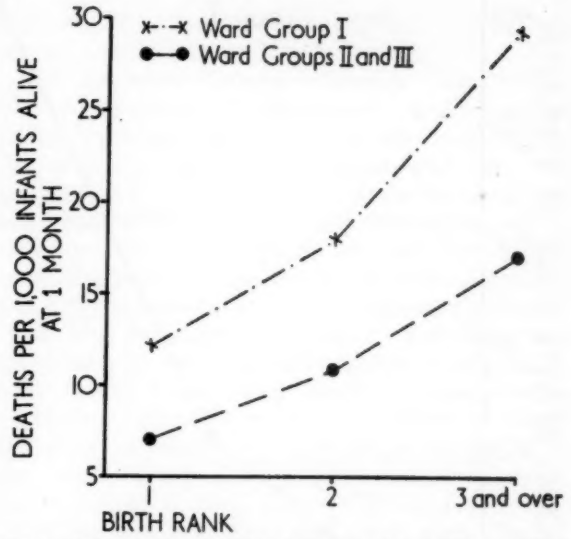

FIG. 1.—Mortality from infection in the second to twelfth months of life, by birth rank and ward group.

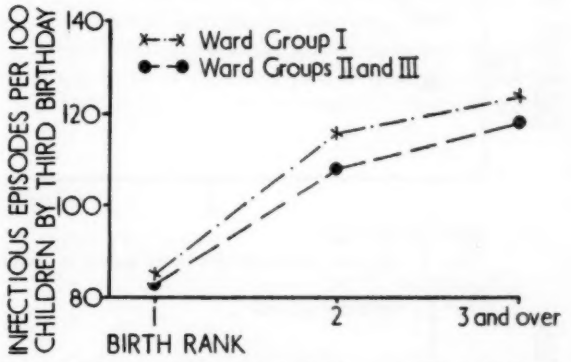

FIG. 2.—Incidence of infection in the first 3 years of life, by birth rank and ward group.

* Maternal age is the age of the mother at the birth of her child.

TABLE II

NUMBER OF EPISODES FROM CERTAIN INFECTIONS (PER 100 CHILDREN) BY THE THIRD BIRTHDAY

Ward Group	No. of Children at Risk	Measles		Whooping Cough		Pneumonia		Diarrhoea and Vomiting	
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
I	708	254	35·9	160	22·6	79	11·2	48	6·8
II and III	1,035	334	32·3	267	25·8	97	9·4	35	3·4
Total	1,743	588	33·7	427	24·5	176	10·1	83	4·8

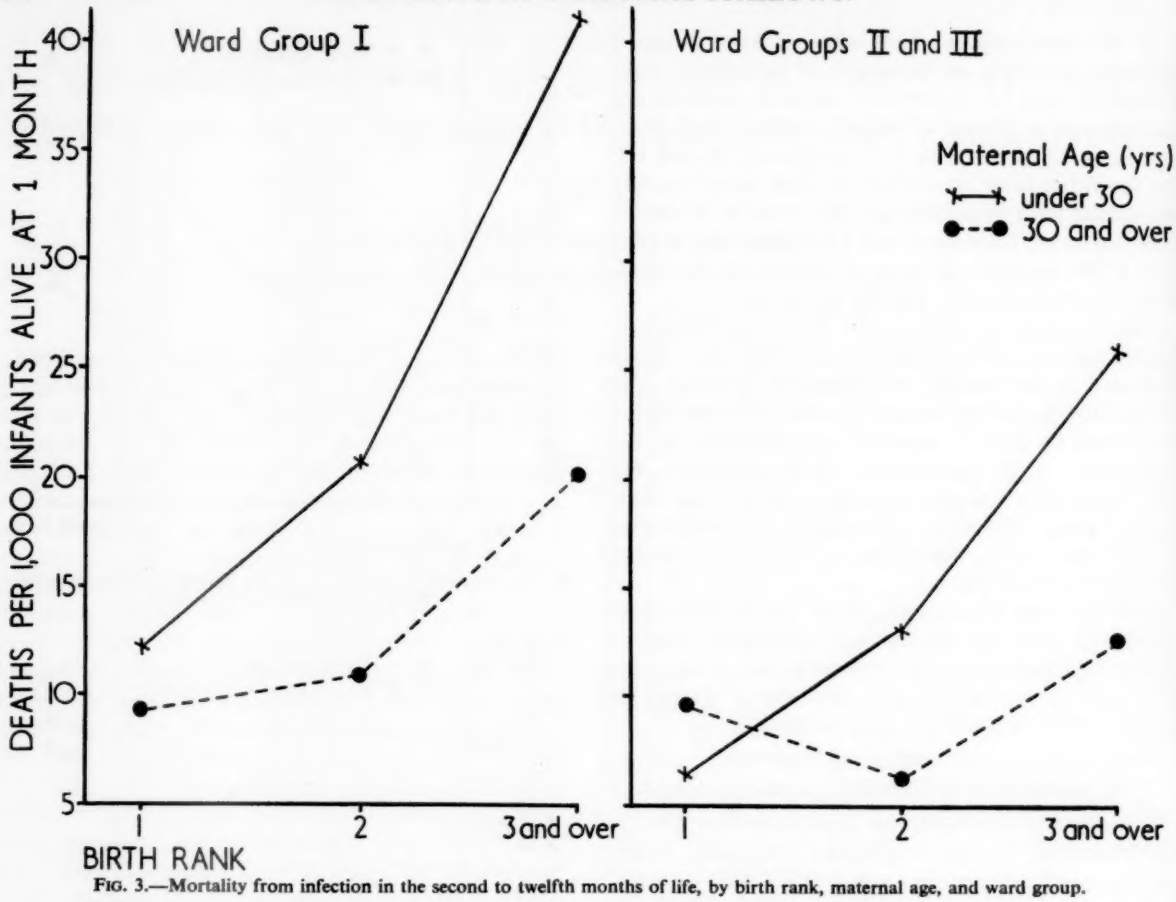

FIG. 3.—Mortality from infection in the second to twelfth months of life, by birth rank, maternal age, and ward group.

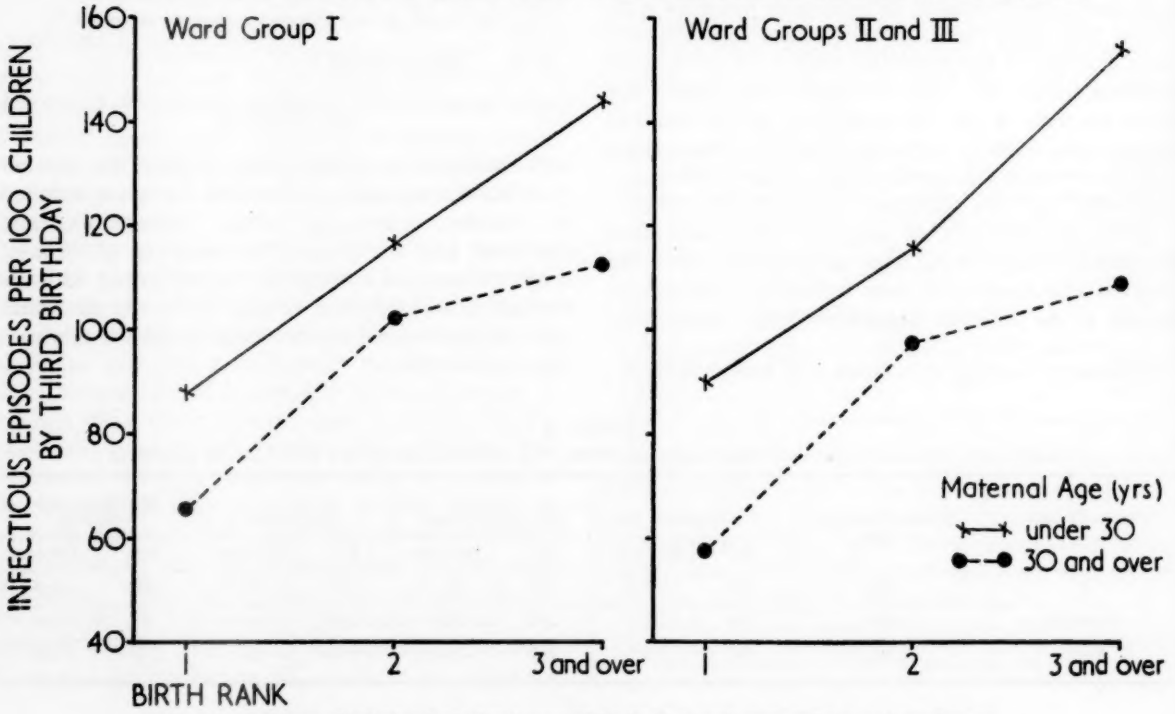

FIG. 4.—Incidence of infection in the first 3 years of life, by birth rank, maternal age, and ward group.

Fig. 5 relates the incidence of the same infections to maternal age and birth order. In all four diseases, incidence increases with increasing birth order, and is lower for older than for younger mothers, the association is particularly marked for measles, which is more than three times more common among the third and later born children of mothers aged less than 30 than among the first born children of mothers aged 30 and over. The results therefore confirm for individual infections the conclusion previously noted, namely that incidence is more sharply related to birth rank and maternal age than to social circumstances identified according to general standard of housing in the area in which children live.

Discussion

The data draw attention to certain limitations of "Social Class" as an index of environmental circumstances. It may therefore be worth while to consider briefly the use currently made in vital statistics of "Occupation". On the one hand it is used to establish risks associated with certain kinds of employment, as for example in the estimation of an occupational mortality index. But occupation is also used less directly as a basis of classification according to social circumstances, and it is with this indirect use that we are here concerned.

The Registrar General identifies five "Social Classes" by means of "Occupation", and numerous *ad hoc* inquiries have adopted the same convention. The difficulty has been to decide upon the best grouping of occupations, which has varied somewhat according to the interests of the investigator. As a rule however, the intention has been to classify according to income, and for this purpose occupation was perhaps as useful as any of the available indices.

As long as gross differences in mortality, and presumably in morbidity also, existed in association with "Social Class", they could be demonstrated without consideration of other variables, of which the most important is undoubtedly family size. But recent investigations indicate that, in parts of Great Britain at least, sharp differences in infant morbidity are not now associated with "Social Class", and the substantial differences in mortality have been attributed, we believe correctly, to differences in case-mortality (Dykes, 1950).

It need hardly be said that it is unwarranted to conclude that the incidence of morbidity in infancy is no longer related to environment. "Social Class"

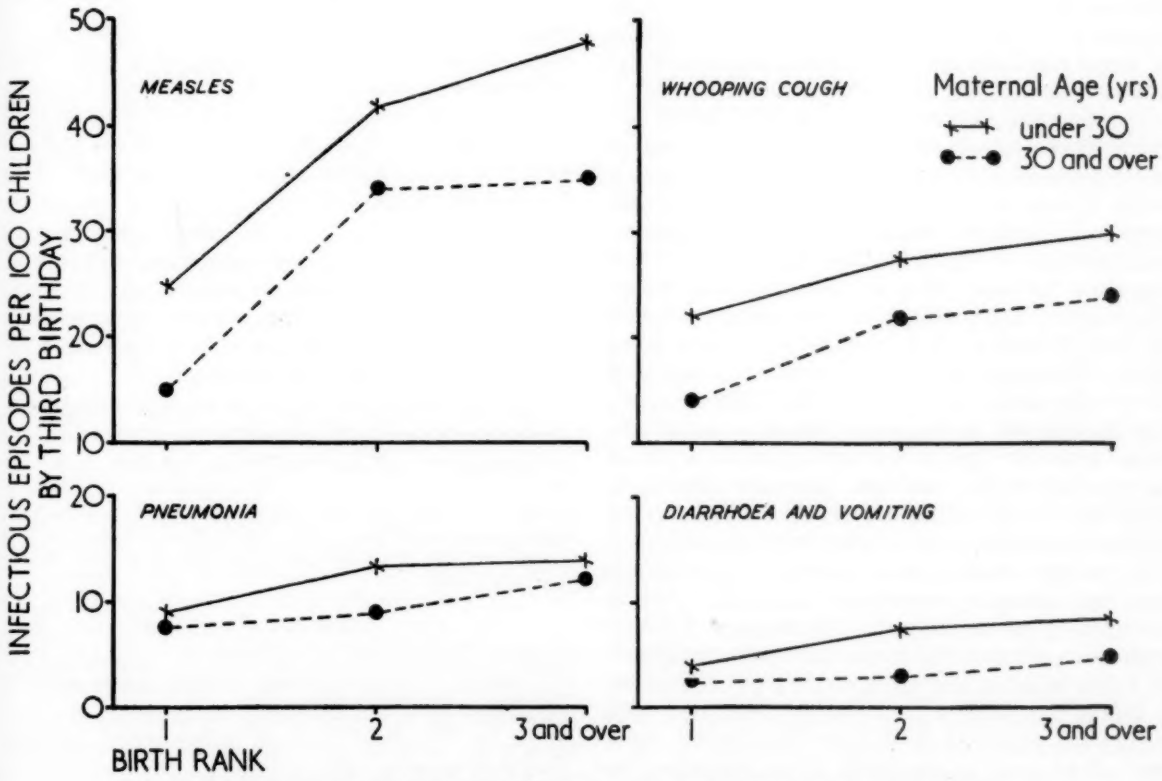

Fig. 5.—Incidence of certain infections in the first 3 years of life by birth rank and maternal age.

is after all only one index of environment, and, chiefly because it takes no account of family size, not a particularly sensitive one. In association with maternal age and birth order much sharper differences can be demonstrated, and since both these variables are recorded in national statistics there seems no reason why they should not be incorporated to provide indices of social circumstances incomparably more sensitive than those now in use.

Finally, we may refer briefly to a possible interpretation of the striking increase in infant mortality, mainly from infectious disease, with increasing birth order. The greatly increased risks of death from infection experienced by late born children derive partly from

(*a*) the possibility of contracting infection, particularly at vulnerable ages, from older sibs,
(*b*) the poorer economic circumstances of large families, which may result in increased susceptibility to infection, and a higher case-mortality among the infected.

The higher case-mortality may be due both to lower resistance, and to less adequate medical attention. In general it seems probable that the increased risks of morbidity referred to under (*a*) are experienced by all social classes, whereas the risks referred to under (*b*) are confined to those families (of which there are still a substantial number) whose incomes are insufficient to provide necessities when there are several children. Expressed differently, risk of infection is raised if the family is large, but risk of death is seriously increased only if it is also poor.

We should also recognize that the association between mortality, birth rank, and economic circumstances is by no means the same for all infectious diseases. Measles and whooping cough are probably fairly accurately accounted for under (*a*) and (*b*) above. But tuberculosis is contracted mainly from adults, and would therefore be expected to be associated with birth order only in poor families and for the reasons referred to under (*b*). Some types of gastro-enteritis appear to be of institutional origin, and are probably related to birth-rank only to the extent that frequency of hospital admission is determined by birth rank.

In another context these observations underline both the immense importance of family size in determining poverty, and the significance of family allowances as a contribution to the health of children. At a time when at least some of the gross differences in infant morbidity and mortality associated with income (as indicated by father's occupation) have been eliminated or reduced, it is important to recognize that it is still possible to identify groups of children whose risk of sickness and death is as high as that experienced by all children in England and Wales in the early years of the twentieth century. These are the late children of large families in poor circumstances, and they can readily be identified for statistical purposes as the late children of young mothers. (Here it is worth noting that the much publicized biological advantages of early conception are usually much more than offset by the social disadvantages which derive from the attempt to raise a large family on an inadequate income.) The case for family allowances is therefore strong, and having regard for the relative effectiveness of alternative social and medical services, it may be asked whether the scale of benefit should not be increased, and graduated according to the number of children, as suggested by the Royal Commission on Population (1949).

Summary

A history of morbidity during the first 3 years of life was obtained from the mothers of 1,743 children born in Birmingham during 1947. It is shown that the incidence of infection was only slightly affected by the general standard of housing in the wards in which children were domiciled, but was sharply associated with maternal age and birth rank. Measles, for example, was more than three times more common among the third and later born children of mothers aged less than 30, than among the first born children of mothers aged 30 and over.

It is suggested that the greatly increased risks of death from infection experienced by later born children derive partly from

(*a*) the possibility of contracting infection, particularly at vulnerable ages, from older sibs,
(*b*) the poorer economic circumstances of larger families, which may result in increased susceptibility to infection, and a higher case-mortality among the infected.

It is noted, however, that the association between mortality, birth rank and economic circumstances is different for different infectious diseases.

We are indebted to Mrs. M. Hopper, who recorded the histories of morbidity. The research was assisted by a grant from the Birmingham University Students' Social Services Fund.

REFERENCES

Douglas, J. W. B. (1951). *Popul. Stud.*, **5**, 35.
Dykes, R. M. (1950). "Illness in Infancy". Leagrave Press, Luton.
——, Grundy, F., and Lewis-Faning, E. (1953). *British Journal of Preventive and Social Medicine*, **7**, 31.
Gibson, J. R., and McKeown, T. (1952). *Ibid.*, **6**, 183.
Grundy, F. (1949). *Med. Offr.*, **81**, 144.
Lowe, C. R., and Gibson, J. R. (1953). *Britiish Journal of Preventive and Social Medicine*, **7**, 78.
Royal Commission on Population (1949). Report (Cmd. 7695) London, H.M.S.O.

Brit. J. prev. soc. Med. (1954), **8**, 29–38

A SURVEY OF MENTAL HOSPITALS AND MENTAL DEFICIENCY INSTITUTIONS IN THE BIRMINGHAM REGION

1. MENTAL HOSPITALS

BY

K. W. CROSS

From the Department of Medical Statistics, University of Birmingham, and Birmingham Regional Hospital Board

1. Introduction

The problem of providing adequate care and treatment for patients suffering from mental disorder has become more acute in recent years for many reasons, not least amongst them being the increased numbers and longevity of the population in conjunction with their greater willingness to seek early advice and treatment. As a result, mental hospitals are faced with the dilemma of increasing their admission rates and at the same time continuing to look after an increasing proportion of long-stay chronic patients who are living longer.

Associated with an increasing psychiatric awareness in the general population, are other social agencies contributing to the increased numbers of patients, such as the unwillingness of families to accept responsibility, and provide a home, for parents too aged or too infirm to look after themselves. All too often therefore, a patient, who is otherwise fit for discharge, remains in hospital because he has nowhere else to go.

The problem is a national one. Even before the last war there was a considerable shortage of beds for mental illness, and the inadequate provision of accommodation in the past has been accentuated by apparent deficiencies in planning since the 1946 Act. In August, 1951, regional boards were told by the Ministry of Health that their planning on the mental side was quite incommensurate with the needs of the situation. Furthermore, the problem of mental hospital accommodation is qualitative as well as quantitative. Most accommodation is extremely out-of-date; only a handful of mental hospitals have been built since 1918, and the majority were in existence before the Lunacy Act of 1890.

Coincident with greater overcrowding at most hospitals, the general shortage of nursing staff has been aggravated by the loss of trained and experienced personnel; and the continuance of the service even at its present level is made possible only by employing less trained personnel and by using many part-time staff. Future staffing problems will be increased by falling recruitment and the high wastage rate of student mental nurses. The former is closely linked with the present financial situation, in that the hospital service cannot compete with industry in respect of salaries and hours of duty. The latter is largely due to overcrowding, and the vicious circle must be broken before improvements can be expected. The consequences of employing larger numbers of domestic staff call for special consideration, since this would lessen the wastage from employment of nursing staff on non-nursing duties.

2. Aims of the Survey

In view of the large number of patients involved, the degree of overcrowding, and the apparent shortages of many types of staff, it was decided that an examination should be made of the type of case at present being cared for and treated in the mental hospitals of the Birmingham Region, with special reference to the most effective utilization of skilled personnel.

By no means all the relevant information for such an investigation in its entirety is readily available from the existing records; it will be possible to give a complete picture embodying all types of information only by modifying the design of individual case records. This survey is therefore concerned with those aspects which could be adequately covered by the use of forms designed for completion at source and without recourse to case records. Thus the immediate aims of the survey include:

(*i*) an evaluation of the type of case on each ward with respect to certain well-defined factors;
(*ii*) a review of the ward-by-ward disposition of nursing and domestic staff and accommodation available;
(*iii*) a review of medical and various other types of staff available at the date of the survey;
(*iv*) an assessment of staff accommodation available;
(*v*) a determination of the present level of operation of psychiatric out-patient clinics.

One type of relevant information calls for special comment in this context because the unavoidable lack of it adds great difficulty to the task of assessing the shortage of qualified personnel. Whether mental patients as a whole make greater or less demands on qualified personnel than other hospitalized cases treated likewise as a whole can be satisfactorily answered only if it is possible to classify both major categories with the same measure of precision. There is in fact no uniform system of diagnostic specification for mental disorders in the country as a whole or the region in particular, nor would it necessarily add much to our knowledge if there were; and the deliberations of the Inter-Services Committee on psychiatric nomenclature during the late war does not encourage the hope of early agreement with respect to terminology, still less with respect to diagnostic classification. Thus the current usage of terms less than ever endorses a clear-cut demarcation between the dangerously sick and those suffering from milder disorders, or of the latter from persons whom we may deem to be normal; and the difficulty of budgeting personnel requirements *vis à vis* case severity is not one which any immediate proposals for improved documentation, unless very drastic, would remedy. Drastic improvements are scarcely practicable in the light of shortages of personnel for documentation in institutions other than general hospitals.

One omission calls for special comment. In the past, and to a varying extent in different regions, general hospitals may have set apart wards for mental patients. In the Birmingham Region this is a rarity, the only notable exception to the segregation of mental patients being the wards provided at Stoke City General Hospital. Thus any error resulting from the exclusion of patients in general hospitals is trivial. Needless to say, a thorough analysis of the work of the out-patient clinics, especially if accompanied by a follow-up, would be invaluable. It is therefore regrettable that it is possible to record so little about the work of the out-patient departments at this stage, for the reason that records kept in the Region to date are of doubtful value.

3. Accommodation Available for Mental Patients in the Birmingham Region

In this Region, which has a population of 4,444,000, 13,200 beds are allocated to mental disease in thirteen hospitals; accommodation is therefore available at the rate of 3,000 beds per million population.* But this level has been made possible only by the provision of a considerable number of beds in addition to the statutory number for which the hospitals were designed.

*The national rate is 3,400 beds per million population.

An examination of ward returns designed for collection of data relevant to 2(*i*) and 2(*ii*) above reveals considerable inter-ward differences in degrees of overcrowding, defined with respect to statutory accommodation* as base. At most hospitals the admission unit is not overcrowded and hence the lower limit of the range of percentage overcrowding is zero in each case. We here consider only the overcrowding at night, this being the more important, and Table I shows for each hospital, for males and females respectively, the number of wards which are overcrowded within certain ranges and the average overcrowding for each hospital as a whole.

Male Side.—Only two hospitals have an appreciable number of wards not overcrowded. Otherwise, at least five wards at any one hospital are overcrowded. In the region as a whole, the proportion of such wards is 71 per cent. Excluding the two hospitals mentioned above, the proportion is 80 per cent. The number of wards overcrowded by less than 10 per cent. is very small, and no less than 35·7 per cent. are overcrowded by 25 per cent. or more. At five hospitals more than half the wards are overcrowded by 25 per cent. or more, and at the Central Hospital four of the eleven wards are overcrowded by 50 per cent. or more.

Female Side.—Only 20 per cent. of the wards are not overcrowded, and at three hospitals all wards are overcrowded to some degree. There appear to be only two hospitals with a reasonable proportion of wards not overcrowded at night. The largest number of female wards appears in the category 25–49·9 per cent. overcrowded. In fact, *half* the wards in the Region are overcrowded at night by 25 per cent. or more, and almost *one-fifth* by 50 per cent. or more. There is only one exception to the rule that there is greater overcrowding in female than in male wards.

4. Analysis of Patients in Residence

We may now proceed to examine data referable to the patients resident in the mental hospitals of the Region at the time of the survey. Relevant information was obtained ward by ward and summarized by

*The assessment of day and night accommodation in mental hospitals is based on prescribed space allowances as given on the Ministry of Health Accommodation Return (Form M.H.S. 3). The statutory accommodation by day is calculated on a minimum area of floor space of about 40 sq. ft. per patient, although a minimum area per patient is given for each of six classes of patients. The statutory sleeping accommodation is calculated, according to the classification of the ward, either (*a*) on beds in position spaced according to prescribed distances between bed centres (about 5 ft. on the average), or (*b*) on the minimum area of floor space (about 50 sq. ft. per patient), the smaller figure being given.

TABLE I

SLEEPING ACCOMMODATION FOR MENTAL PATIENTS IN THE BIRMINGHAM REGION

Name of Hospital	Statutory Accommodation	Number of Patients	Per cent. Overcrowding	Wards Open	Wards Overcrowded	Wards Overcrowded by			
						< 10 per cent.	10–24·9 per cent.	25–49·9 per cent.	50 per cent. and over
MALES									
St. George's ..	433	495	14·3	13	10	1	2	4	3
St. Edward's ..	569	682	19·9	13	10	—	3	6	1
Winson Green ..	488	560	12·9	11	8	2	4	2	—
Rubery Hill ..	353	329	—	7	6	3	1	1	1
Hollymoor ..	332	297	—	9	3	1	2	—	—
Highcroft Hall ..	500	461	—	9	2	—	2	—	—
Burghill ..	232	232	0·0	7	5	3	2	—	—
Powick	377	440	16·7	8	6	—	3	3	—
Barnsley Hall ..	276	328	18·8	7	6	—	2	4	—
St. Matthew's ..	483	532	10·1	10*	7	1	3	3	—
Central	466	593	27·3	11	9	—	2	3	4
Shelton	364	461	26·6	7	7	1	1	5	—
All Hospitals ..	4,873	5,410	11·0	112	79	12	27	31	9
FEMALES									
St. George's ..	531	705	32·8	13	11	1	—	5	5
St. Edward's ..	545	702	28·8	13	13	—	4	4	5
Winson Green ..	592	805	36·0	14	12	1	2	6	3
Rubery Hill ..	439	584	33·0	11	11	2	2	5	2
Hollymoor ..	307	336	9·4	8	4	—	1	3	—
Highcroft Hall ..	727	708	—	14	9	3	2	3	1
Burghill ..	270	298	10·4	8	5	1	1	1	2
Holme Lacy ..	106	73	—	3	—	—	—	—	—
Powick	482	575	19·3	9	8	—	5	2	1
Barnsley Hall ..	325	399	22·8	8	8	4	1	2	1
St. Matthew's ..	534	644	20·6	18	14	2	7	4	1
Central	532	772	45·1	14	12	—	—	7	5
Shelton	506	561	10·9	9	7	4	1	2	—
All Hospitals ..	5,896	7,162	21·5	142	114	18	26	44	26

*Excluding eight dormitories which together are overcrowded by 11·3 per cent.

hospital for males and females separately. In what follows a regional summary is given for each of a number of items, together with the range of inter-hospital variation where appropriate.

It should be mentioned at the outset that the in-patient populations of two hospitals are exceptional in many aspects. One was a Poor-Law institution before the "Appointed Day"; here most patients are still classified as voluntary cases, and a high proportion of in-patients are aged 65 years and over. The other is small in size and the patients in residence are mostly female voluntary cases over 65 years of age. In view of these peculiarities these hospitals may not always be mentioned in subsequent reference to extremes of the following distributions.

Age Distribution.—The number of patients falling into each of three age groups is given in Table II, which also shows the proportions of the total in-patient population classified as Voluntary, Certified, etc., for each age group specified. The Table shows that 0·4 per cent. of the male and 0·6 per cent. of the female patients in residence were under 16 years of age. St. Edward's Hospital and Highcroft Hall Hospital

TABLE II

AGE AND CLASSIFICATION (ACCORDING TO SECTION OF L.M.T.A.) OF PATIENTS

Sex	Section of L.M.T.A.	Under 16 Yrs		16–64 Yrs		65 and Over		All Age Groups	
		No.	Per cent. of All Patients	No.	Per cent. of All Patients	No.	Per cent. of All Patients	No.	Per cent. of All Patients
Male	Voluntary ..	1	0·0	824	15·2	259	4·8	1,084	20·0
	Certified	23	0·4	3,376	62·4	908	16·8	4,307	79·6
	Other	—	—	15	0·3	4	0·1	19	0·4
	Totals	24	0·4	4,215	77·9	1,171	21·7	5,410	100·0
Female	Voluntary ..	5	0·1	898	12·5	538	7·5	1,441	20·1
	Certified	21	0·3	3,739	52·2	1,916	26·7	5,676	79·2
	Other	18	0·2	16	0·2	11	0·2	45	0·6
	Totals	44	0·6	4,653	64·9	2,465	34·4	7,162	100·0

are the only two with a not insignificant number of patients in this age group. A far higher proportion of males than females falls within the age-group 16 to 64 years, and this holds for each hospital. On the *male* side, there are abnormally large proportions (over 30 per cent.) of patients aged 65 years and over at two hospitals, and the range of variation about the regional average of 21·7 per cent. is from 14·7 to 32·7 per cent. On the *female* side, more than one-third (34·4 per cent.) of all patients are aged 65 years and over, and for individual hospitals this proportion varies from 25·7 to 39·3 per cent. The age-composition of the in-patient population will be discussed in greater detail in Section 7, when the consequences of current trends will be considered.

Classification of Patient Population according to Section of Lunacy and Mental Treatment Act.—This also merits comment. In Table II patients not classified as voluntary or certified (*i.e.* temporary patients, "place-of-safety" cases, etc.) have been grouped together in view of the very small numbers involved. The proportions of voluntary and certified patients in the Region as a whole are almost identical for males and females, and exactly one-fifth of all patients in residence are voluntary patients. With respect to these proportions, however, there are considerable variations between hospitals. On the *male* side, most hospitals have less than 20 per cent. voluntary patients whilst Highcroft Hall Hospital and Central Hospital far exceed this value. At one hospital (Barnsley Hall) the proportion of certified patients is as high as 91·4 per cent. and at four other hospitals more than 85 per cent. are certified. On the *female* side, the highest proportion of certified female patients is 92·8 per cent. (Rubery Hill), and at four other hospitals more than 85 per cent. are certified.

By means of Table II it is possible to relate age to classification. The proportion of voluntary cases (and hence of certified cases) for all adults is, it appears, the same as for each age group, taking into account the relative proportions of patients within those age groups. Thus there is no association between age and classification in the Region as a whole for either sex. We find, however, that in a few individual hospitals there are outstandingly high or low proportions of certified patients in one or other of the age groups.

Length of Stay.—This is also a circumstance of considerable value when assessing the type of patient residing in a mental hospital. Of all patients in the Regional mental hospitals, 85 per cent. have been resident for a year or more. Since a patient who has been in hospital for such a period is unlikely to be discharged, this proportion is a rough measure of the magnitude of the chronic section of the in-patient population. There is little variation from hospital to hospital in respect of this proportion; the highest figure for both sexes is 91·5 per cent. (Winson Green) and the lowest figures are 78 and 69 per cent. on the male and female sides respectively.

A more conservative estimate of the proportion of chronic patients is given by the 70 and 72 per cent. of males and females respectively who have been in hospital more than 3 years. The high proportions (88 and 86 per cent. respectively) at Winson Green Hospital are again very outstanding. Excluding Hollymoor Hospital, which was re-opened in 1949, only two hospitals have proportions for either sex below 70 per cent. Slightly more than 61 per cent. of all patients have been in residence more than 5 years. Several hospitals have proportions above 70 per cent, and, with the exception of Hollymoor and Holme Lacy, more than half the patients in residence at each institution on the day of the survey had been in residence for *longer* than 5 years.

Mobility, Incontinence, and Assistance Required.—In any assessment of the type of patient on a particular ward, with special reference to the disposition of trained personnel, it is necessary to make due allowance for the proportions of bedridden and incontinent patients, and for the degree of assistance required in feeding, bathing, etc. An examination of the number of patients on each ward requiring various forms of assistance showed that differing interpretations placed upon the recording of such data would not permit any comparison between hospitals, and the information recorded was deemed to be useful only for considering the disposition of personnel between wards at a particular hospital, as outlined in the classification of wards referred to below.

The regional summary for mobility and incontinence is given in Table III (opposite), which shows that about one-tenth of the male and one-eighth of the female patients are bedridden. There is less variation between hospitals in respect of the female proportions than of the male proportions, and at each hospital, with one exception, the proportion of female bedridden cases is higher than the corresponding male proportion. In the Region as a whole, almost 40 per cent. of the bedridden males and about 60 per cent. of the bedridden females require the bed-pan, and regardless of their mental states, such patients make considerable demands upon nursing strengths of hospitals. Many patients are, of course, both bedridden and incontinent, and hence require medical and skilled nursing supervision. Those that

TABLE III
MOBILITY AND INCONTINENCE OF PATIENTS

Type of Patient	Males		Females	
	Number	Per cent. of All Patients	Number	Per cent. of All Patients
Bed-ridden	514	9·5	917	12·8
Requiring bedpan	204	3·8	561	7·8
Ambulant ..	4,896	90·5	6,245	87·2
Working ..	2,859	52·8	2,723	38·0
All Patients ..	5,410	100·0	7,162	100·0
Incontinent ..	534	9·9	1,312	18·3

are only incontinent may also require the service of a nurse or doctor at any time, irrespective of the degree of mental change, and the care of incontinent patients presents a greater problem on the female side than on the male at the large majority of hospitals.

Patient Labour.—Table III also shows that 53 per cent. of the male and 38 per cent. of the female patients in residence were working, although the proportion of workers of course varies considerably from hospital to hospital. Details of the place of employment of each patient were obtained, and it was found that 29 per cent. of the males and 23 per cent. of the females were working in their own wards. As would be expected, a much greater difference between the sexes in the proportions of patients working elsewhere was found, *i.e.* 24 per cent. for males and 15 per cent. for females. At most hospitals a greater proportion of the female patients work in the wards than elsewhere in the hospital. At several hospitals the converse is true on the male side.

To assess the value of patient labour wholly in terms of actual work done is misleading, since it takes no account of relief to members of the hospital staff, especially nursing staff, by keeping the patients occupied. Patient labour is also to some extent a form of occupational therapy. In considering such figures we must therefore take into account the proportions of patients at each hospital receiving prescribed occupational therapy in the more usual sense of the term. These proportions for the Region as a whole are 11 and 13 per cent. for males and females respectively, although again there are considerable inter-hospital differences. Since the same patients at some hospitals do routine work and also receive occupational therapy, proportions for workers and patients on occupational therapy are not additive.

There may well be, between hospitals, differences of interpretation with regard to what constitutes occupational therapy in contradistinction to work. However, at nine of the twelve hospitals at least *half* of the male patients and at least *one-third* of the female patients in residence are kept occupied for some part of the day. Of these patients, those working elsewhere (*i.e.* other than on wards) probably contribute most to the services of the hospital, and patient man-hours calculated for such patients are more meaningful in terms of staff units than those relating to ward workers.

Special Mental Treatment.—The proportions of patients receiving occupational therapy have already been cited, and this form of treatment is the most common. Convulsion therapy is given at all hospitals, and some patients seen at the out-patient clinics become in-patients to receive it. Insulin shock therapy is given at most hospitals, although the number of patients receiving it on any given day is very small. Since the number of patients receiving any particular treatment will vary from week to week or month to month, it would be more instructive to cite an average over a sufficient period of time; but this was found to be impracticable. The results obtained from the ward returns pinpoint the treatment wards and hence assist in classifying the patients therein.

Classification of Wards by Type of Patient.—In the absence of information referable to the mental state of patients in residence, it is instructive to examine the ward returns with a view to classifying the wards at each hospital by type of patient against the background of various items considered above. It was found that wards may be classified into four major groups:

I Admission units and other wards with a large proportion of recent cases (over 50 per cent of the patients with a length of stay of less than 1 year);
II Wards with large proportions of bedridden cases;
III Wards with ambulant patients who for the most part are non-workers or working on their own wards;
IV Wards with a large proportion of patients working outside the wards.

The first group comprises wards housing patients with short durations of stay, and who are mostly voluntary patients under 65 years of age. At each hospital there is at least one ward for each sex in this group and such a ward is also conspicuous by the large proportion of patients receiving special mental treatment. The wards which fall into the second group are also clearly defined, since at each hospital bedridden cases, with very minor exceptions, appear to be confined to selected wards. A high proportion of these patients are 65 years of age or over and many require feeding and other assistance. There

are more wards for this type of patient on the female side than on the male.

The remaining wards house patients who, with very minor exceptions, are all ambulant, and these may be separated into the third and fourth groups mentioned above by considering the proportion of patients working outside the wards. Broadly speaking, those patients employed outside the wards are likely to make less demands on the services of nursing personnel than other ambulant patients, and such a separation has been made with a view to what follows. The wards which fall into the fourth group are also distinguished by the small numbers of patients requiring assistance, and this group includes the non-observation wards. There are very few border-line cases, and the only wards excluded from the classification are isolation wards. These are small in number and size and do not merit further analysis. This classification will be used in the following section to review the availability of certain grades of staff at the time of the survey.

5. Staff

Medical Staff Employed.—Table IV shows the numbers of whole-time medically-qualified staff employed in the Region at the end of 1952 by grade, together with patient-staff ratios. At most hospitals there are two consultants and one S.H.M.O., and in addition one or two J.H.M.O.s. Few Senior Registrars are employed and half the hospitals have no medical staff of S.H.O. or H.O. grade. The Table shows that slightly more than half the total medical personnel are of consultant or S.H.M.O. grade and that a quarter are of J.H.M.O. grade. These figures reflect the difficulties in recruiting junior medical officers. There are 360 patients per consultant or S.H.M.O. in the Region as a whole, although, considering the inter-hospital variation, this ratio varies from 200 to 500. Similarly, the range of variation about the regional average of 186 patients per doctor is from 100 to 240.

It has been suggested that there should be one doctor for every 150 resident patients, and that where extra-mural duties are undertaken the staff should be larger (Blacker, 1946). Only two hospitals in this Region conform to this level of staffing, but such ratios take no cognizance of the type of patient.

It has not been possible to assess the time spent by medical staff at the psychiatric out-patient clinics, nor the time spent in the various duties of medical personnel in the hospital. However, the figures cited throw some light on differential availability of various grades of staff throughout the Region.

As regards other medical staff employed, only three persons appear to be undertaking part-time service in the mental hospitals of the Region; and in view of the difficulties experienced in filling full-time posts, it would seem that a considerable increase in part-time service might be made.

Nursing Staff Employed.—By recourse to the ward returns previously mentioned, an attempt has been made to give a picture of the disposition of nursing staff by ward on any one day or night. The large proportion of part-time female nurses employed complicates the issue as regards the female wards, and the more so in the absence of data bearing on severity of cases, since the disposition of nurses from day to day presumably depends to some extent upon the type of patients being cared for and the degree of overcrowding, etc. It was apparent from the survey that there was a daily shift system at only one hospital. Elsewhere, full-time nurses work on the wards for 12-hour periods on both day and night duties. The long hours worked per duty, together with the allowance for staff on leave and sick, mean that only about half the nursing strength of the hospital is available for duty at any one time. For this reason, and because at each hospital there are senior members of the nursing staff who do not work on the wards, an evaluation of total nursing staff to patients in residence is certain to be unrealistic.

The grade of nursing staff (whether trained, student, or assistant) was obtained, and with few exceptions each ward is covered by day, in the first instance, by a trained member of staff. At night many wards do not have staff allocated to them but are patrolled at regular intervals by staff from other wards or by a small complement of relief staff. It is possible to review the availability of nursing staff against the background of the four-fold classification

Table IV

MEDICAL STAFF EMPLOYED

Grade					Number of Patients in Residence	Number of Patients per Consultant or S.H.M.O.	Number of Patients per Doctor
Consultants and S.H.M.O.s	Senior Registrars and Registrars	J.H.M.O.s	Other	Total			
35	7	16	10	68	12,572	362	186

of wards made in Section 4 above, thus taking into account, to some extent, the type of patient involved. A consolidation of the figures given for each ward by recourse to this classification provides patient-staff ratios at each hospital for trained, student, and other staff respectively. These ratios vary from hospital to hospital within the same class of wards, and the size of each ward has some bearing on the allocation of nursing staff. But the overall ratios for the Region as a whole for each class give reliable estimates of the relative availability of different grades of staff, and such ratios are exhibited in Table V for male and female wards respectively. Each ratio depicts the number of patients who, on the average, are looked after by a nurse of a given grade during the day-time.

TABLE V

CLASSIFICATION OF WARDS BY TYPE OF PATIENT AND AVAILABILITY OF NURSING STAFF

Type of Ward		Type of Staff			
		Trained	Student	Nursing Assistants	Total
Male	I	12	29	83	8
	II	19	74	124	14
	III	22	250	65	15
	IV	26	667	200	22
	All	21	128	103	15
Female	I	21	38	27	9
	II	33	57	23	11
	III	42	204	30	16
	IV	60	259	57	26
	All	39	107	27	15

The disposition of *trained staff* on both the male and female sides is clearly defined, and for each group of wards there is a greater availability of male trained staff. As would be expected, patient-staff ratios increase throughout from the first group to the fourth group, although a much greater proportion of trained staff is allocated to the last group on the male side. This difference is probably attributable to the fact that some male staff go out to work with the patients, whereas female patients working outside the wards are supervised by catering and laundry staff. On the male side trained staff appear to be allocated to the second and third groups in almost equal proportions, whereas on the female side there is a considerable difference in the degree of allocation between these two groups.

The patient-staff ratios for *student nurses* increase far more rapidly over the four groups than do the above ratios for trained staff. Male student nurses are allocated almost entirely to the short-stay wards and to the wards with bedridden cases, and in proportion to the number of patients respectively involved they are, of course, mainly allocated to the former group. Female student nurses are similarly dispersed, although a not insignificant proportion is allocated to the third group. The student coverage of the admission units is more satisfactory on the male side, and the converse is true for the other three groups.

The disposition of *nursing assistants* is not so clearly defined as for the foregoing grades of nursing staff, and presumably their allocation is partially associated with the shortage of student nurses. There is a much greater degree of availability of this grade of female staff than male, and the female distribution is probably more representative of the method of allocation. A large proportion of female nursing assistants is employed on wards in the third group; but relative to the number of patients involved they are allocated in almost equal proportions to the first three groups, with a slight preponderance in the second. The lowest patient-staff ratio for this grade of male staff appears in the third class of wards, and, as for the female side, the highest ratio is in the fourth.

The patient-staff ratios reveal a negligible difference between the male and female wards in total staff coverage for any one group; there is one nurse to fifteen patients for each sex when all wards are considered. The final analysis for nursing staff by grade, irrespective of type of ward, shows that there are almost twice as many male as female trained nurses available per patient and almost four times as many female as male nursing assistants per patient. There are slightly more female students per patient than male.

The foregoing results indicate the disposition of nursing staff available at the time of the survey, taking into account inter-ward differences with respect to patients cared for. They may therefore be used to assess more accurately than hitherto the availability of staff at a particular hospital, but it remains to decide how many staff of different grades *should* be employed on a ward of a given type. Prerequisite to a judicious decision is a thorough analysis of the nursing problems involved, against the background of the above classification.

Domestic Staff and Ward Orderlies.—There is little domestic staff on the wards and the number of ward orderlies available at each hospital is very small. Work on the wards is almost entirely done by patient labour under supervision of nursing staff. In practice, this means that nurses are likely to become involved in domestic work, since patient labour is commonly unreliable. As the numbers involved are so small it is difficult to obtain a true picture of the disposition of these types of staff, and an analysis by type of ward, as previously given in

respect of nursing staff, is not satisfactory. However, it may be stated that domestic staff and ward orderlies are mainly allocated to Ward Types I and II on both the male and female sides, there being approximately three times as many members of staff per patient on these wards as on the others. In proportion to the number of patients involved, about three times as many females as males are available at any one time, and very few part-time male domestic staff are employed.

6. Psychiatric Out-Patient Clinics

An exhaustive analysis of the work of out-patient clinics was not possible for the reasons given in Section 2, but we may review the turnover of these clinics at an elementary level by recourse to basic administrative data, such as the number of new patients, the total out-patient attendances, and the number of consultant sessions. Such figures were available for 1952 for each mental hospital and each out-patient department in the associated general hospitals.

The medical staffs of the mental hospitals hold clinics at 25 general hospitals in the Region, and out-patients are also seen at most of the mental hospitals. During 1952, 3,813 consultant sessions were held, at which 6,775 patients attended for the first time during that year, so that on the average *two* new patients were seen per consultant session, There is, of course, some variation from clinic to clinic about this Regional average in respect of the average number seen per session, the two extremes being 0·3 at one cottage hospital and 5·4 at one of the large general hospitals. The average number of all attendances (new and old) per consultant session is found to be 7·8 for the Region as a whole, although there is considerable variation from clinic to clinic. Broadly speaking, therefore, *two* new and *six* old patients are seen at a single session.

7. Discussion

It is doubtful whether many participants in public controversy concerning the need for economy realize that one-half of all the persons for whom the Birmingham Regional Hospital Board, like many others, has the responsibility of providing institutional accommodation are mentally deranged or defective. From this survey, several aspects of the problem of appropriate provision of accommodation for the former class of patient are brought into focus, and by an examination of mental hospitals on a ward basis the gravity of the present situation in other respects is more clearly defined. The degree of overcrowding on individual wards has been ascertained and the results reveal a shortage of accommodation which is often underestimated by reliance on a figure for overcrowding in a hospital as a whole. The consequences of such a level of overcrowding are very apparent. They include:

(*i*) poor facilities for the clinical classification of patients;
(*ii*) the with-holding of in-patient treatment from potential voluntary patients who would benefit therefrom;
(*iii*) falling recruitment and high wastage of student nurses.

While it is not intended to underestimate the value of medical supervision where neither treatment nor prevention is the end in view, the blunt truth is that the problem of accommodation is essentially a domestic one. In fact, the problem of appropriate provision for mental patients has much in common with the problem of appropriate provision for the chronic-aged, inasmuch as it is the responsibility of the Health Service to discharge the dual function of:

(*a*) efficient treatment of remediable cases;
(*b*) humane hotel-keeping on behalf of the incurable.

On the other hand, it presents difficulties and opportunities peculiar to its forensic implications and to the historical background of the disposal of persons in need of protection or of restraint.

Estimates of the relative proportions of these two classes of patient, (*a*) and (*b*) above, are given by the analysis of patients in residence by length of stay. It is probably true to say that on any one day at least 85 per cent, of the total in-patient population are chronic cases in that they are unlikely ever to leave hospital. In terms of costing, this raises the question: can we effect beneficial economies by segregating the remediable where expert services are more readily available and the incurable in equally congenial circumstances without redundant provision of medical personnel at consultant level. It is not intended to discuss here the consequences of an affirmative answer to this question, since they involve consideration of another issue, *viz.* the practicability and advisability of treating certain types of mental illness in hospitals other than those under review.

Unless new circumstances conspire to reverse or partially eliminate current trends, it is difficult to see how the present very serious situation can be prevented from deteriorating in the immediate future. Not only is the population of England and Wales steadily increasing, but it is, at the same time, ageing, and, since the incidence rates of certain psychoses increase with age, the population of mental hospitals is likely to increase. This survey has shown that 22 per cent. of all male patients and 34 per cent. of all female patients resident at the

present time in mental hospitals in the Birmingham Region are 65 years of age or over, as compared with 9 per cent. and 12 per cent. respectively in the general population. If we relate the numbers of patients in residence to the total population by sex and age-group, we find that per 10,000 of the *male* population there are 34 patients in residence aged between 16 and 64 years inclusive and 70 patients aged 65 years and over. The corresponding rates for *females* are 36 and 105. Since we may expect both the proportion of people over 65 years of age and the proportion of females to males in this age-group to increase, it is certain that greater demands on beds will be made during the next two decades unless discharge and death rates increase to the same extent. There appears to be no indication that new treatments will materially increase the discharge rate; and there is every reason for assuming that the death rate will decrease.

However, an examination of other aspects of the current situation, particularly of the incidence of first admissions by sex, age, and diagnosis, will have to be undertaken before making even tentative estimates of future requirements in terms of beds, staffing, and ancillary facilities. This issue will be dealt with in a subsequent contribution. Without the introduction of new incentives, it is also abundantly clear that the difficulties of recruitment and retention of staff, particularly of junior medical staff and of nursing staff, will continue. The shortage of the former might be partially offset by effecting an increase in the numbers of doctors employed part-time. The shortage of nursing staff would appear to be even more serious, and a review of trends over recent years gives some indication of the magnitude of the problem confronting the Mental Health Service. It will suffice to give a few facts:

(*i*) The number of trained nursing staff has remained fairly constant since 1947, although on the female side this constancy has been maintained by employing more part-time qualified nurses.

(*ii*) The number of student nurses in training has steadily decreased, and in 1952 was the lowest ever.

(*iii*) The number qualifying is decreasing, and 40 per cent. of female students and 5 per cent. of the male students leave the Mental Health Service on qualifying.

(*iv*) The retirement rate among qualified staff is about 5 per cent. per annum.

(*v*) To offset these reductions larger numbers of nursing assistants are being employed. Such staff are, of course, ineligible for the posts of ward sister or charge nurse, and offer no security for the future.

It would appear, therefore, that it is unlikely that mental hospitals will in future years be able to maintain even the present level of nursing staff if the present trends continue. The high wastage rate of 80 per cent. for student nurses is perhaps the most serious aspect of the present situation. The gross overcrowding on many wards is an important contributory factor and the impact of such conditions upon a young nurse just leaving the preliminary training school is considerable. Another important aspect of student-nurse wastage is that staff shortages exclude the possibility of selective recruitment.

The accommodation available at each hospital for full-time staff, together with the number of quarters occupied on the day of the survey, was obtained separately for each type of staff. It was found that all quarters set aside for medical staff were occupied at most hospitals and that presumably any increase of medical staff would necessitate a re-organization of existing quarters. It would seem that with few exceptions, adequate provision has been made for female nurses, *quantitatively speaking*, and it is doubtful whether, even if an appreciable increase in the nursing strengths was effected, all the available quarters would be filled. On the other hand, very few of the available quarters for male nurses were unoccupied, and for maintenance and domestic staff there were no vacant quarters at most hospitals either within the hospital buildings or outside. An increase of quarters for male resident staff would probably facilitate recruitment, although it appears that, in view of the long hours spent in the hospital buildings, nurses are likely to prefer their living quarters to be situated elsewhere.

8. Summary

(1) An examination has been made of several of the problems of providing adequate care and treatment for patients resident in the mental hospitals of the Birmingham Region.

(2) The survey reveals the greater degree of overcrowding at night of the female wards than of the male, and shows that at many hospitals only the admission units and sick wards are not overcrowded.

(3) The analysis of patients in residence shows that:

(*a*) 34 per cent. of the female and 22 per cent. of the male patients are over 65 years of age, and 0·6 per cent. of the female and 0·4 per cent. of the male patients are under 16 years of age;

(*b*) one fifth of all patients in residence are voluntary patients;

(*c*) 85 per cent. of all patients have been in residence for more than one year and 70 per cent. of the male and 72 per cent. of the female patients have been in hospital for more than 3 years; with the exception of two hospitals, more than half the patients at each institution have been in residence for longer than 5 years;

(*d*) one-tenth of the male and one-eighth of the female patients are bedridden, and at all hospitals, with one exception, the proportion of female bedridden patients is higher than that of the male patients; one-tenth of the male and almost one-fifth of the female patients are incontinent;

(*e*) at least half the male patients and at least one-third of the females are kept occupied for some part of the day;

(4) A review of medical staff at present employed shows that few Senior Registrars and Registrars are employed, and that many hospitals have no junior staff; in fact more than half the medical personnel are of consultant or S.H.M.O. grade.

(5) An assessment of nursing staff available has been made, classifying wards according to type of patient; and patient-staff ratios have been calculated for each group. These may be used to examine the extent of nurse coverage of a particular type of ward at any one hospital. The relative values of these ratios also reveal the current use of the available staff in different types of ward.

(6) The consequences of present trends with regard to both patients and staffs are commented upon.

I should like to record my appreciation of the co-operation which I have received from the staffs of the mental hospitals, in particular from the medical superintendents and nursing staffs who were concerned in the extraction of detailed information referable to the patients in residence. My thanks are due to Dr. Raymond Wrighton, one time Research Fellow in this Department, for his invaluable assistance in the collection of data and for his constructive criticism in the compilation of this report. Finally, I wish to express my gratitude to Professor Lancelot Hogben, F.R.S., for his advice at all stages of this survey.

REFERENCES

Blacker, C. P. (1946). "Neurosis and the Mental Health Services". Oxford University Press, London.
Board of Control: Lunacy and Mental Deficiency (1953). "39th Annual Report, 1952". H.M.S.O., London.
FitzGerald, O. (1953). *Brit. med. J.*, 1, 1,392.
Lancet (1952). 2, 344. (Notes and News—unsigned.)
Ibid. (1953). 2, 176. (Annotation—unsigned.)
Ibid. (1953). 2, 715. (Annotation—unsigned.)
Ibid. (1953). 2, 927. (Annotation—unsigned.)
Norris, V. (1952). *Ibid.*, 2, 1172.
Petrie, A. A. W. (1953). *Brit. med. J.*, 2, 43.
Sandison, R. A., and Spencer, A. M. (1953). *Ibid.*, 560.